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Control Galvanic Corrosion to Prevent Costly Failures

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Gasket Materials—Properties and Uses

Preheat Temperatures for Welding

Chromium Carbides

TOOL STEELS—TYPES, USES AND TREATMENTS
—Materials & Methods Manual No. 85

AUGUST
1952

THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

How's this

for putting brains to work?

For more than 70 years, Cook Well Strainer Company, Inc., of Lawrenceburg, Indiana, has been making well strainers. For many of these years slotted seamless brass tubes, up to 12″ diameter, proved wholly adequate. But the insistent demand for more and more water called for deeper wells of larger diameter—and strainers to meet the new needs.

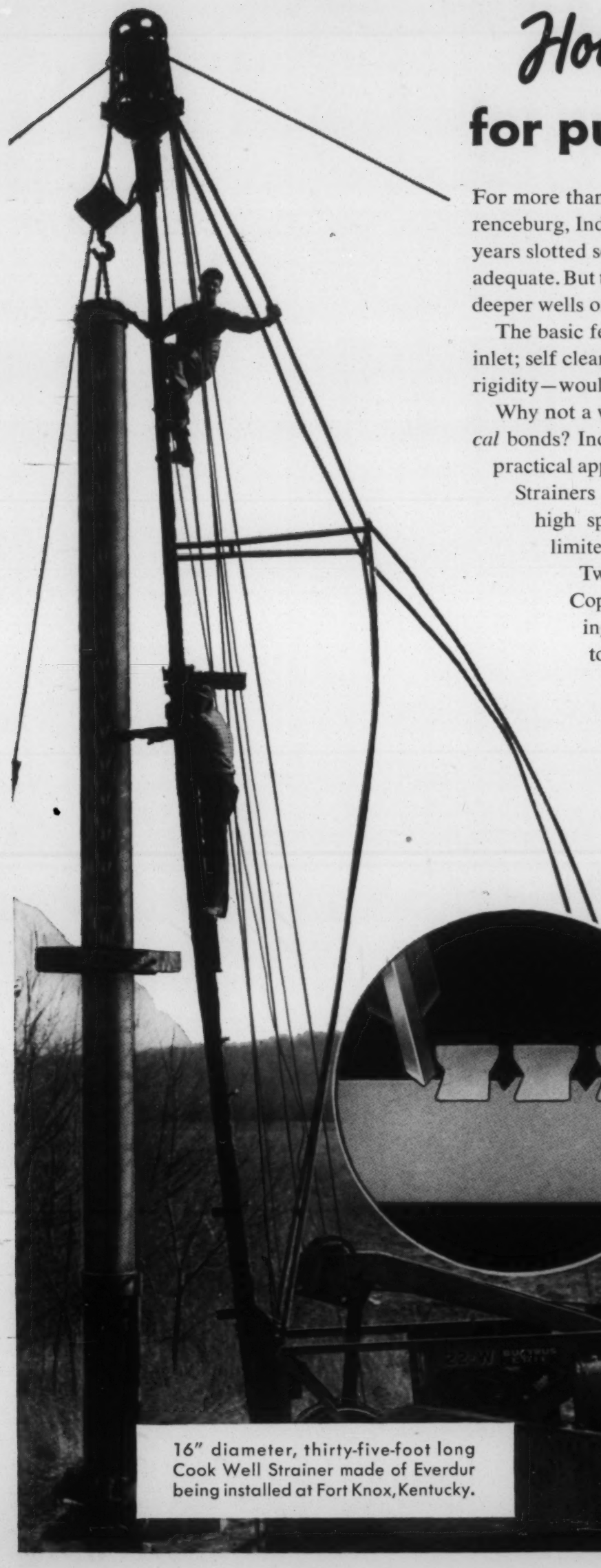
The basic features of the famously successful tube strainer—direct inlet; self cleaning slot, larger inside than outside; one metal; strength; rigidity—would have to be duplicated in larger diameters.

Why not a wire-wound strainer with automatically-made *mechanical* bonds? Indeed, why not? The illustrations on this page show the practical application of this ingenious idea. Cook Wire-Wound Well Strainers are now made in sizes up to 40″ inside diameter—at high speeds, with slot widths readily variable, and lengths limited only by handling facilities.

Two Anaconda Metals, Red Brass-24 and Everdur*-1010 Copper-Silicon Alloy, have proved themselves outstanding for this application. Both machine readily, are plenty tough to withstand upsetting, contribute strength for the required rigidity, and provide excellent resistance to a wide variety of corrosive ground waters. Your problems may be different, mechanically or chemically, but if they involve copper, brass or bronze, call on The American Brass Company, General Offices, Waterbury 20, Connecticut.

5292

*Reg. U.S. Pat. Off.



16″ diameter, thirty-five-foot long Cook Well Strainer made of Everdur being installed at Fort Knox, Kentucky.

As the supporting skeleton of bars revolves in this winding machine, each bar is machine-notched ahead of the spirally wound wire (see circle illustration). This wire is a special drawn Anaconda Shape of modified keystone cross-section. A circular form tool then displaces the metal on one side of the V-groove into the dovetail section of the wire, locking it securely.

the name to remember

ANACONDA

COPPER, BRASS & BRONZE

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When a steel order goes through a mill, customers have a big advantage when everyone concerned with production decisions is handy and available. Inland's size and location mean that prompt personal attention can be given to every customer's problem as it comes up.

INLAND

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The Materials Outlook

Before the steel strike, the output of boron steels was 2½ times what it was in the beginning of 1951. The boron steel tonnage had climbed to nearly 9% of total nonstainless alloy production. The monthly average last year was 4% of nonstainless alloy tonnage. . . . The monthly production of alloy steel was 778,500 tons at the beginning of this year. The monthly average before Korea was 550,000 tons.

Aluminum will be used more and more in electrical apparatus. For equal resistance, aluminum conductors weigh one-half that of copper conductors. The cross section is increased, though. . . . The strength, elongation, thermal conductivity, expansion and creep rate of aluminum must be considered in new applications. Aluminum is as strong as copper in the hard drawn state, but not in the annealed. The lower annealing and melting points of aluminum raise problems in wire enameling, brazing, soldering and burning off enamel. Corrosion at copper-aluminum joints must also be considered.

General Motors is proud of its accelerated wear and corrosion testing program. Quick results are obtained on a series of alloys to narrow down the number to be tested further. . . . The corrosion tester operates at 125 F, with humidity varying from 100% to 10% and back over an 8-hr cycle. The specimen is flooded with a 1 sodium chloride, 1 calcium chloride and 0.1% sulfuric acid solution once per cycle. In 20 days, results approximate 3 year's exposure at Kure Beach. The immersion solution simulates the residue on winter city streets after snow-melting materials have been used.

New turbo-jet engine oil is thin but extremely stable. The new oil will pour at -65 F. It lubricates in the 500 F range found in the rear main bearings of aircraft engines. Anti-corrosion properties are good; resistance to oxidation is high.

Progress has been made by Northrop Aircraft and Alcoa on the Air Force project to cast magnesium airplane wings. A wing section 16 ft long, ¼-in. thick in places, is cast to close tolerances by undisclosed methods. It is believed wings can be made cheaper than by riveting or spot welding aluminum skins to spars and ribs. AZ-92 magnesium alloy is used. Additional work is needed before the method is ready for regular production.

An adhesive-tape resistor developed by the National Bureau of Standards features compactness, stability and high temperature operation. The newest version is made by coating asbestos paper with carbon black or graphite, silicone resin and solvent. Two pieces of uncured tape sandwich suitable wire or metal ribbon leads. A heat cure gives a resistor that can be soldered

(Continued on page 4)

The Materials Outlook *(continued)*

or spot welded into the circuit. Electronic printed circuits are the big applications.

A 100-ton precision molding press installed in the Plastics Branch of the Naval Ordnance Laboratory permits molding laminate test panels with precise control of temperature, pressure and time. Platens are chromium plated, with parallelism held to 0.006 in. per ft. Pressure up to 347 psi can be held to an accuracy of 0.2% of the load. Temperatures as high as 500 F can be developed in the platens. Time-pressure history of a molding, or pressure versus platen travel may be automatically recorded.

A new theory on blackening of metals promises better processes for producing black coatings on metals. The research was done by Lehigh's Institute of Research and Enthone, Inc. The theory explains the reactions in black nickel plating and sulfide blackening. It enables the selection of chemicals and conditions for blackening metals like steel, stainless steel, zinc and cadmium.

A new silicone chemical developed by GE is water soluble. It is available for experimental purposes. . . . Applied directly or used as an integral mix, it imparts water repellency to a variety of materials. The major application looks like masonry water repellents. Other uses may be in repellents for textiles and paper, catalyst preparations, additives for sodium silicates, and additives for water-base paints to improve washability.

The first major improvement in metal-oxide rectifiers since their introduction in 1926 is claimed by the National Bureau of Standards. The new rectifier has a layer of semi-conducting titanium dioxide, a sheet of titanium and a counterelectrode of some other conducting metal. . . . The units withstand 20 v per plate in the reverse direction and actually perform better with increasing temperature up to 300 F.

New chemical stabilizer is designed to produce non-discoloring and non-staining synthetic rubber. The chemical will find use in light colored synthetic rubber products, is said to add heat stability and to guard against destructive effects of heat and oxygen during storage and processing.

New rubber-like material is being produced in pilot-plant quantities. The material is described as completely resistant to ozone and is a prospect for use in tire treads and white-sidewall tires, protective coating for weather-stripping in cars, new blends of rubber, and insulation.

After years of giving up markets to thermosetting plastics, ebonite (black, vulcanized hard rubber) is attempting a comeback. Recent Dutch research indicates that plants to produce the material can be built for less than phenolic or dry rubber processing plants. With pressures of only 10 to 25% those required for phenolics, ebonite can match these materials in flexural strength, surpass them in impact resistance.

See page 6 for "Materials Control Orders"

U. S. Commission Forecasts Great Expansion of Metals Markets by 1975

Needs Will Probably Outstrip Supplies.

A five-volume report issued recently by the Materials Policy Commission attempts to forecast, for many years ahead, the raw materials outlook for this country and suggests ways of stabilizing supplies and prices of commodities on a global scale. The recommendations call for world agreements on production and distribution of raw materials, and for international stockpiles which could be used to manipulate world supplies and prices.

In order to calculate American metals needs, the Commission estimated the growth of our economy. Two basic assumptions were made—that the U. S. working force would be 82 million in 1975, and that man-hour productivity will increase 2.5% a year between now and 1975. With these assumptions, the Commission reports:

Steel: The steel industry will pour 147 million tons of ingots and use 110 million tons of steel products in 1975. This compares with 1950 consumption of 97 million tons of ingots and 68 million tons of steel products.

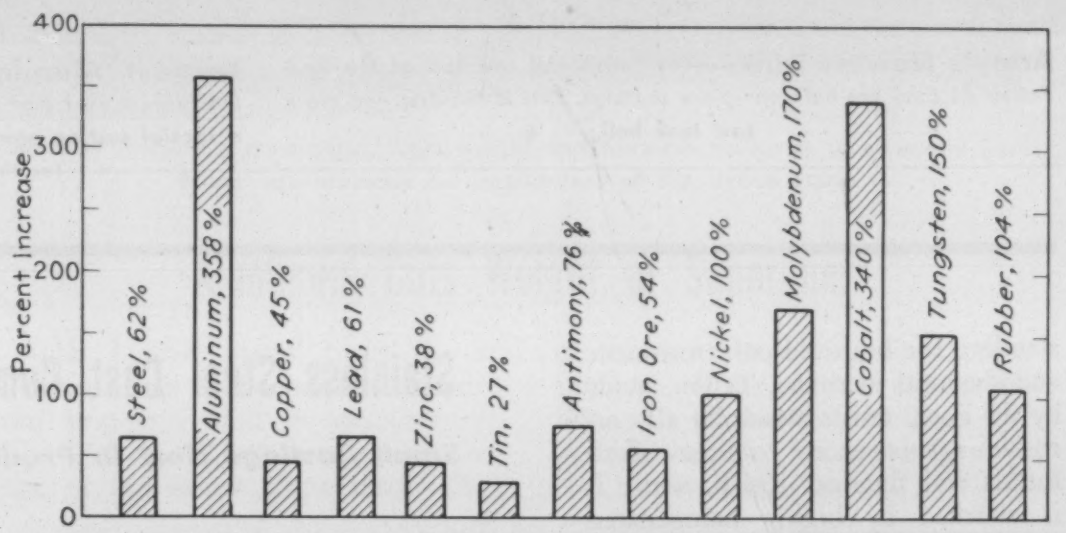
Aluminum: Total consumption of the light metal will amount to 4.5 million tons, compared with 980,000 tons in 1950—an increase of 358%.

Copper: A total 1975 consumption of 2.5 million tons, compared with 1.7 million tons in 1950, an increase of 45%.

Consumption of other materials will rise by the following percentages over 1950: Lead, 61%; zinc, 38%; tin, 27%; antimony, 76%; iron ore, 54%; nickel, 100%; molybdenum, 170%; cobalt, 340%; tungsten, 150%; and rubber, 104%.

Two major weak spots show up in the Commission's forecasting techniques:

All the predictions involve the assumption that 1975 materials prices will maintain just about the same relationship they held in 1950. Any substantial departure from the old relationship, however, could completely distort the pattern of requirements mapped out by the Commission.



Predicted percentage increase in United States consumption of metals, 1975 over 1950.

More important, radical technological advances could completely upset the forecasts. To get some idea of the kind of job the group is trying to perform, imagine the difficulty a similar set of forecasters would have faced in trying to forecast 1950 materials demands from the vantage point of 1925. They would have failed to foresee the tremendous impact of the television set, the vacuum cleaner and the home air conditioner. They would have had no inkling of atomic power. They would probably have drawn a blank on synthetic textiles. By 1950, their estimates would probably have borne no resemblance whatever to the actual state of the nation's economy.

William S. Paley, chairman of the Columbia Broadcasting System, headed the Commission which prepared the report. Other members were: George Rufus Brown, chairman of the board of Texas Eastern Transmission Corp.; Arthur H. Bunker, president of Climax Molybdenum Co.; Eric Hodgins, an editor of *Fortune* magazine; and Edward S. Mason, professor of economics at Harvard University.

Fluorocarbon Plastics Production Expands

Yearly Output of Kel-F Expected to Top One Million Pounds.

Plans for production in expanded commercial quantities of Kel-F fluorocarbon plastic have been announced by The M. W. Kellogg Co. Production facilities scheduled to go into operation this year in Jersey City, N. J., will increase the yearly output of Kel-F to more than one million lb. Manufacturing economies should allow further price reductions.

Kellogg's plans are indicative of the growing interest in the fluorine plastics. These materials are out-

(Continued on page 10)

Army's Newest Tank—*The turret and the hull of the new Patton 48 tank are both one-piece castings. This is the first one-piece cast tank hull.*

Largest Aluminum Ingots—*These aluminum ingots are the largest ever cast for forging or extrusion. Kaiser Aluminum uses a special casting process to prevent cracks. Large ingots are needed for the Air Force big press program.*

standing for heat and cold resistance and chemical inertness. Teflon, made by du Pont, resists attack by all corrosive agents except molten alkali metals and fluorine. Kel-F, while it is attacked by highly halogenated compounds and various aromatics in addition to the molten alkali metals and fluorine, can be processed in conventional equipment by compression, injection and extrusion techniques. None of these standard methods can be applied to Teflon. Both materials can stand exposure to —100 F. Kel-F can be used up to 350 F, while Teflon is good up to 500 F. The Union Carbide and Carbon Corp. fluorine plastic Fluorothene is assumed to be roughly equivalent to Kel-F. At present, unfabricated Teflon sells for about $5.50 a lb, while Kel-F goes for $12 a lb. Fluorothene is still in the pilot plant stage and is not available commercially.

There are still a number of stumbling blocks in production and fabrication of fluorine plastics, but research is being pushed in both fields. Kellogg confidently predicts a continuation of the downward price trend, indicative of better production methods. Fluorine plastics are now used for gaskets, liners, wire insulation, valve parts and electronic parts. In the near future, they may be used for coatings for metals, in high quality lubricants, for food packaging materials, and in aviation elastomers. Many new uses will depend upon lower prices and better fabrication methods.

Stainless Steel Cast Commercially in Shell Molds

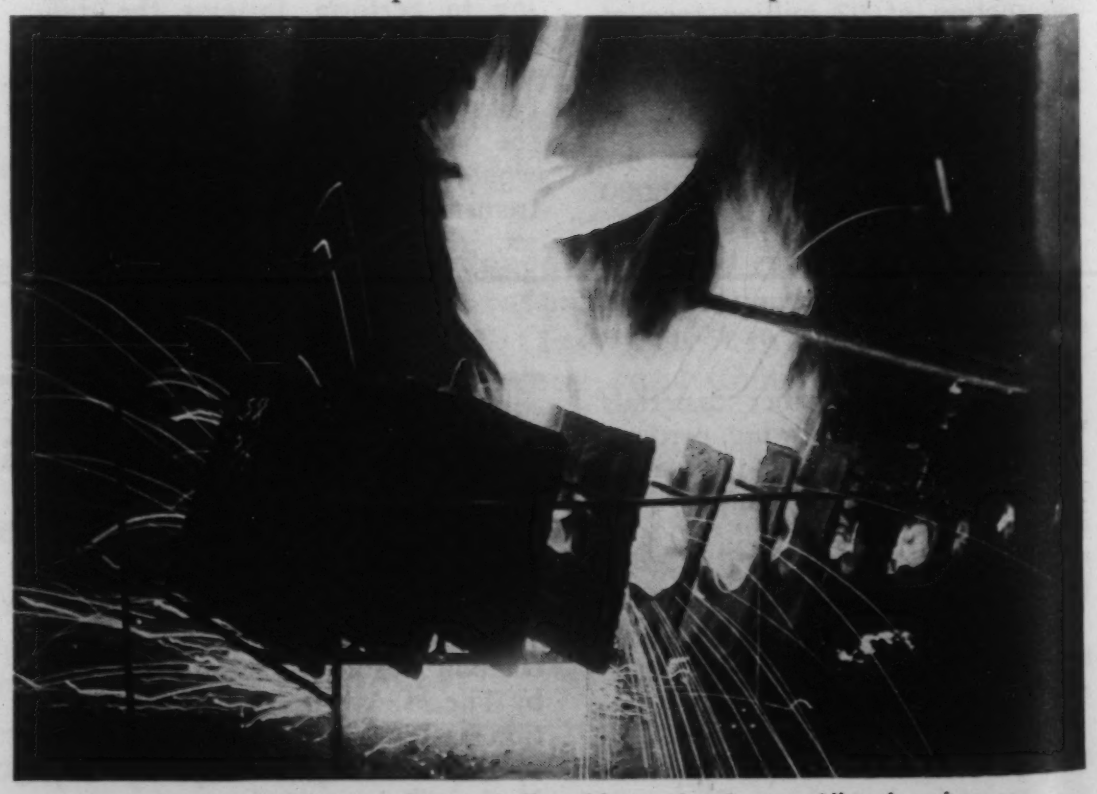
Small Castings Now in Production, Larger Ones on Way

Commercial production of stainless steel castings by the shell molding process has been announced by the Cooper Alloy Foundry Co. Small castings of types 304 and 316 stainless steel are in production. Experimental work now in progress is expected to lead to the production of much larger castings.

In commercial production now are stainless steel valve parts and fittings of the smaller sizes which comprise the major output of this foundry. In experimental production are a jet afterburner casting which requires very close mold matching, a ring for a disposal unit and a milk funnel.

Molds

The molding sand mixture consists of 8 phenolformaldehyde, 5



Pouring stainless steel into shell molds at the Cooper Alloy foundry.

rouge, ¼% wetting agent and the balance sand. Because of the greater permeability of a shell mold, it is possible to use sand with an AFS fineness number of 160, a grade much finer than that which can be employed in green sand molding. The use of this fine sand and rouge improve the surface condition of the castings. Aluminum patterns covered with a silicone parting compound to facilitate removal of the shell and heated to 500 F are used to form the shell. The length of time the sand mixture remains in contact with the hot pattern determines the thickness of the shell, which for stainless steel ranges from ⅛ to ¼ in.

The molds are sealed with a special tape, which when placed between the hot mold halves and compressed, melts and forms a bond strong enough to withstand the pressure developed during pouring. This procedure has been adopted for all the commercial molds produced in the Cooper foundry and has proved very satisfactory. Molds are used without backing and breakouts have averaged less than 4%, although the steel is poured at a temperature of 3100 F.

Advantages

The unbacked mold has a number of advantages, including easier shake-out of castings, cleaner working conditions and less handling of waste materials. Unbacked molds also cool more rapidly than backed molds and the rate of production can be increased.

In comparison with sand molds, shell molds can be prepared faster and less skill is required. For equivalent output, unbacked shell molds occupy much less floor space than sand molds.

Closer tolerances are achieved with shell molding, and the general surface condition of the casting is improved greatly. It has been found possible to cast sections as thin as ⅛ in. in shell molds, a procedure which is not practical in sand casting. It is expected that even thinner sections can be cast. Reduction of scrap losses is an additional advantage. In a number of the parts previously cast in sand, the major causes of rejects were shifts, cold-shuts, missruns and dirt. Changing to shell molds for these parts eliminated shifts and cold-shuts completely, and reduced rejects from an average of 40% to a fraction of that figure.

The easy forming characteristics, light weight and corrosion resistance of aluminum were found advantageous for applications of the United States.

Aluminum Cuts Weight of Superliner

The United States Lines' S. S. United States is the largest commercial ship ever built in this country. The 990-ft., 52,000-ton liner is also one of the fastest ships afloat. One of the most interesting construction features of the ship is the liberal use of aluminum. Millions of pounds are used for more than 60

(Continued on page 13)

Matter of Fact
BY EDWARD A JOSEPH
THE BRITISH EXPECT TO HAVE THE FIRST
ALL-PLASTIC AIRPLANE
IN THE AIR WITHIN TWO YEARS
A DELTA SHAPED WING OF HIGHLY POLISHED MOLDED PLASTIC ALREADY HAS BEEN PRODUCED
IT IS MADE OF ASBESTOS FIBERS BONDED TOGETHER BY A RESIN TO FORM LARGE SOFT SHEETS RESEMBLING FELT
DUCTILE CAST IRON,
UNLIKE THE BRITTLE ORDINARY GREY CAST IRON, IS THE RESULT OF A METHOD DEVELOPED IN 1948 OF USING A NICKEL-MAGNESIUM COMBINATION AS AN ALLOYING AGENT
ALUMINUM
PRODUCTION IN NORTH AMERICA NOW EXCEEDS THE COMBINED OUTPUT OF COPPER, LEAD AND ZINC
THERE ARE NOW MORE THAN 2000 END USES OF THE LIGHT METAL, WITH ITS AVAILABILITY FOR OVER 1300 PRODUCTS IN THE ARMED FORCES ALONE

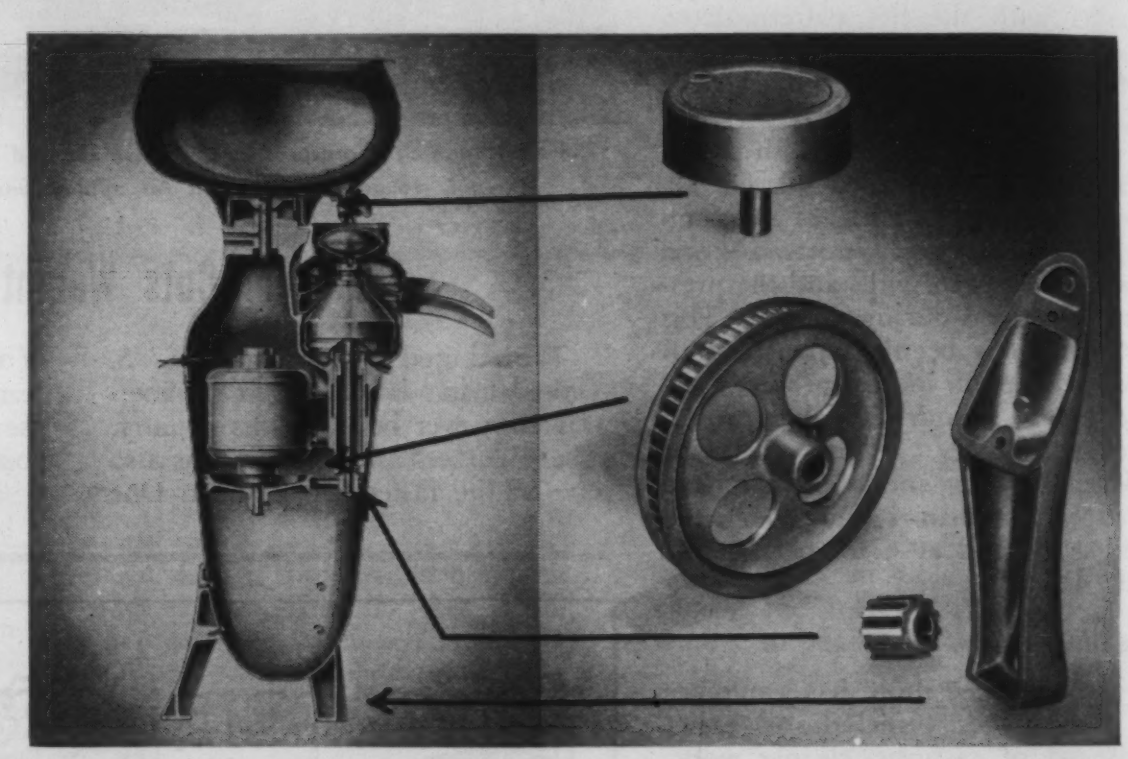
get the mo$t for your Zinc Die Ca$ting Dollar!

SPECIAL HIGH GRADE ZINC
—the grade used in
die casting alloys—
IS NOW IN AMPLE SUPPLY

STREAMLINE THE DESIGN

Today's competitive selling calls for advanced styling—whether the product be one for factory, farm or home. Consider the product pictured below—the latest addition to the De Laval line of cream separators. It is completely streamlined for maximum appeal to the 1952 farm family—a far cry from the separator that you remember from your boyhood farm visits.

There is more to the advanced styling of this product than meets the eye. It has been redesigned *inside* and *out* to achieve maximum quality at minimum cost and, as with countless other products, this goal has led to the use of ZINC Die Cast components. The tooth-type motor and spindle pulleys, the collar which supports the supply can and the three legs of the new centrifugal separator were designed by De Laval engineers to get the most for their ZINC Die Casting Dollar!



MINIMIZE ASSEMBLY

Each of the ZINC Die Castings pictured above is designed to reduce both machining and assembly operations. The teeth on the two pulleys are integrally cast with a high degree of dimensional accuracy for quiet, efficient operation with a corrugated belt. Only simple broaching operations are required on these pulleys and the one-piece construction minimizes assembly time—and cost. The supply can supporting casting also reduces assembly, since the steel shaft is cast as an insert.

All unnecessary metal has been eliminated in the design of these die castings. The leg casting, for example, has a massive outward appearance but, actually, it is cored in the casting operation to reduce to a minimum the amount of metal consumed. ZINC Die Castings are inherently tough and do not require excessively heavy sections to meet strength requirements.

ASK FOR DESIGN HELP

The surest way to realize the full physical and economic advantages of ZINC Die Castings is through consultation with a competent die casting engineer in the *early* design stages. Any die casting company will welcome the opportunity to be of service. Also ask that company for a copy of "Designing For Die Casting"—or write to us.

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ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

News Digest

continued from page 11

applications. This emphasis on aluminum is indicative of the favorable price position of the metal and the tremendous increase in production facilities.

Light weight and corrosion resistance are two advantages of aluminum. The superstructure, more than 600 ft long, is largely made of aluminum alloys. This is one of the weight-saving features. The aluminum smoke stacks, the largest ever installed on a ship, save weight and add to the stability of the ship. More than 65,000 rivets were used on each stack. The radar mast, framed and plated with aluminum, weighs less than half what a comparable steel mast would.

Aluminum is also used extensively inside the ship. More than 1000 shower stalls were assembled by inert gas-shielded welding. Crew's lockers, pipe berths for the crew's quarters, dog kennels, ventilation ducts, screening, window frames and hand rails are made of aluminum. The easy forming characteristics of the metal were valuable in many of these applications.

Army Conserves Critical Materials

Substantial savings in the use of critical and strategic materials as a result of the Army's conservation program have been announced. The program, initiated in September 1950, achieves its objectives primarily by substitution for critical materials in short supply. Simplification of design is also used, providing this does not involve sacrifice of essential military or safety characteristics.

For example, Ordnance officials found that lean alloy steels can be substituted in certain tank and artillery components without compromising the battleworthiness of the weapon. Similarly, welded steel tubing, which is in relatively ample supply, is replacing scarce seamless steel tubing in many items.

In one case it was found that a

(Continued on page 176)

to the man who wants
UNBIASED ADVICE *on* MOLDING MATERIALS

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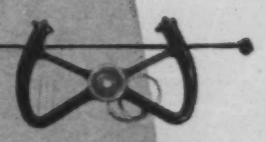
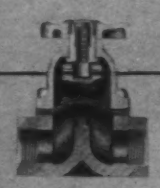
HARD RUBBER GUN PLATE

ACE PARLAN® — Tough cellulose acetate-butyrate, high impact up to 9.4 Izod. Good for housings, control wheels, handles, etc.


PARLAN STEERING WHEEL

ACE PARIAN® — Polyethylene; tensile to 3,000 psi; dielectric to 700 v/mil, unaffected by most acids, alkalies and salts. Good for chemical, electrical parts.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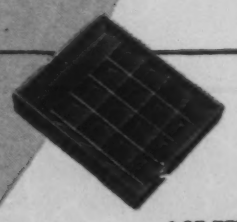
ACE-HIDE CHAIR ARM PAD

ACE-TEX® — Not rubber, not plastic, but a pyrobituminous molding material. Relatively low strength, high chemical resistance. Used in auto battery cases, containers, etc.


ACE-TEX TRAY

American Hard Rubber Company

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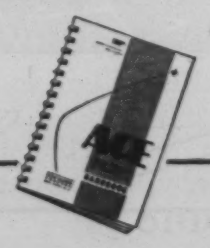

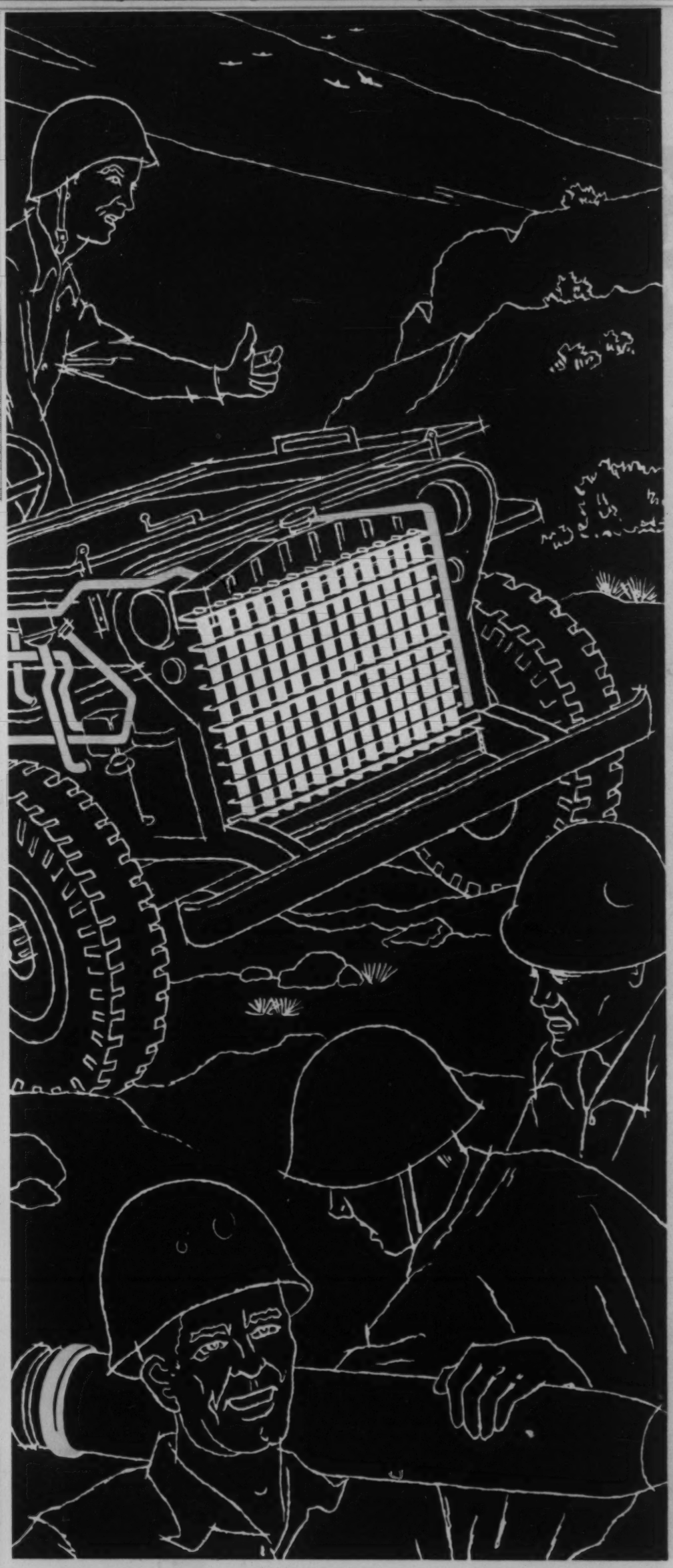

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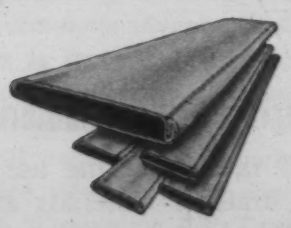
WHEREVER quality and long life count, you'll find American industry using H & H brass and copper tubing and fabricated parts. The H & H LOCKSEAM tubing in the jeep radiator at the left is widely used in automotive heating and cooling components, while the fabricated parts shown in the same illustration are typical of other H & H applications. If *your* operation calls for tubing that will *last*, call your nearest H & H representative *first*.



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H&H TUBE AND MANUFACTURING COMPANY
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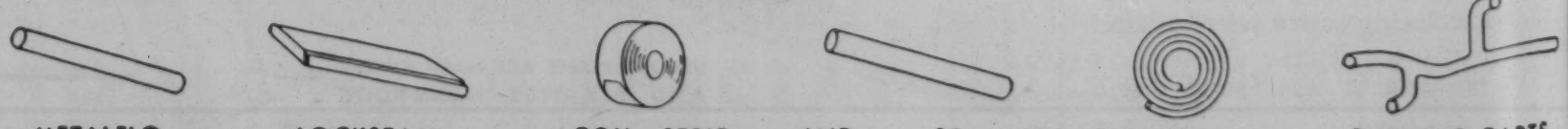
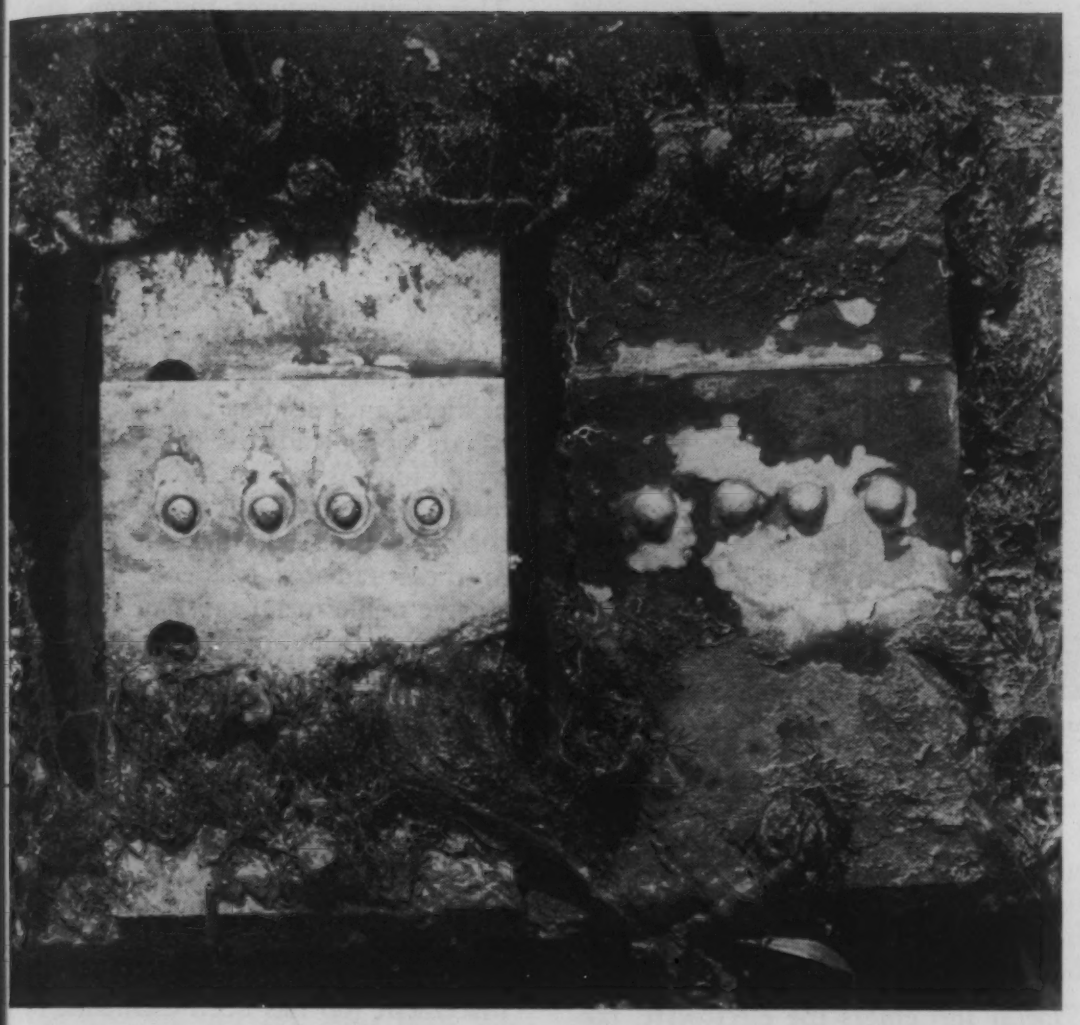


METALFLO LOCKSEAM COIL STRIP AND SEAMLESS TUBING TUBULAR PARTS



The effect of area in galvanic corrosion is shown by these assemblies. Severe corrosion of steel rivets joining copper plates, left, contrasts with the less intense corrosion of steel plates fastened with copper rivets (right). (International Nickel Co.)

Control Galvanic Corrosion ...Stop Costly Failures

The engineer has a choice of several methods to either eliminate galvanic action or control its destructive effects, including protective coatings, inhibitors and sacrificial anodes.

by **E. C. REICHARD**, American Smelting & Refining Co.

● RECENTLY, A MAJOR corporation encountered a galvanic corrosion problem which resulted in the recall of over 200,000 automobiles for parts replacement, at an estimated direct cost of 20 million dollars. In another instance it cost over a million dollars to replace a half-million fire extinguishers made defective by corrosion. These were admitted costs; but many costs chargeable directly to corrosion are either not admitted or go unrecognized. No wonder Dr. Uhlig estimates the cost of corrosion in the United States around $5500 million per year.

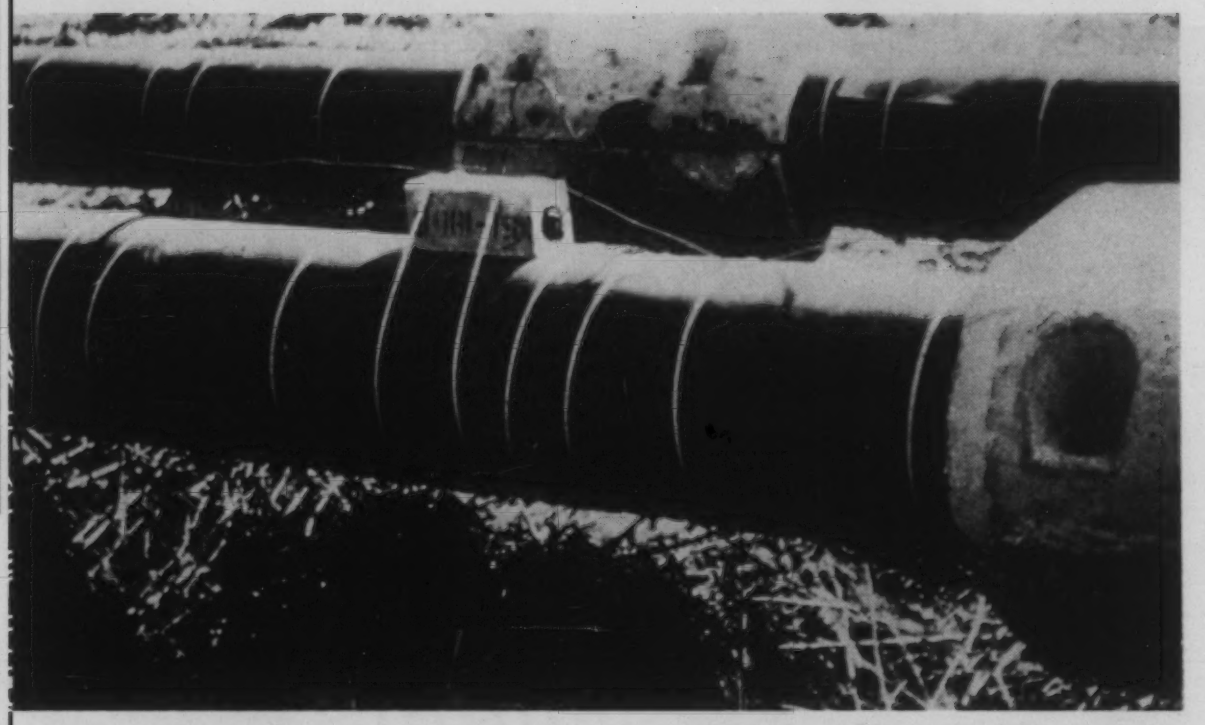
Many of these costly corrosion problems could be avoided if the principles of galvanic corrosion were fully understood. In addition, the principles of galvanic corrosion can be usefully applied in preventing corrosion failures of critical structures.

The Galvanic Cell

Two different metals that are in metallic contact with each other form a galvanic cell whenever an electrolyte is present. An electrolyte can be any material, generally a liquid, that conducts electricity. Common electrolytes are sea, salt or fresh waters, soils and many liquids.

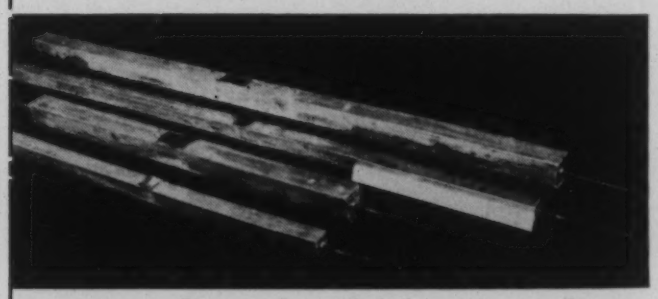
One of the most common galvanic cells is the ordinary flashlight battery. It consists of a carbon and a zinc electrode with a special electrolyte placed between them. When the two electrodes are shorted, 1½ volts of electricity are obtained and the resulting current is used every day in lighting lamps and actuating relays.

An active galvanic cell has two reactions—anodic and cathodic—which

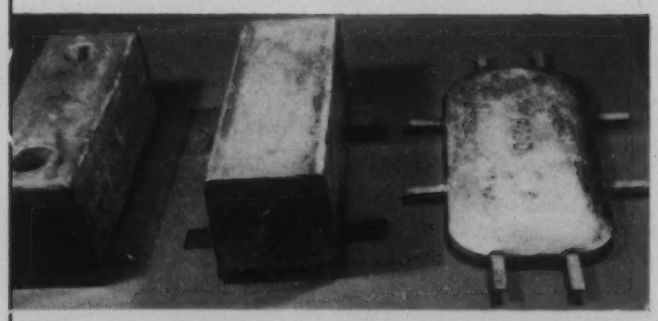


Transcontinental gas transmission lines are protected by attaching expendable magnesium anodes during installation.

Magnesium anodes with lead wires for attaching to buried structures such as pipe lines.



Zinc anodes with full length cores for protecting buried structures.



Magnesium anodes for the protection of the exterior hull surfaces of active ships. The small anode on the right is designed for fresh or brackish water service, the others for sea water service.

take place simultaneously. The anodic reaction of the galvanic cell occurs where a metal ionizes and leaves an excess of electrons. At this place, a galvanic current leaves the metal and enters the electrolyte, taking some metal with it. The cathode of a galvanic cell is similar to the cathode upon which other metals are deposited in the plating shop and in the electrolytic refining industry. No corrosion normally occurs at the point of the cathodic reaction.

Thus, the anode metal is destroyed, whereas at the cathode, metal is protected. The current density at the anode determines the corrosion rate. The greater the current density the greater the galvanic corrosion. Since the anode area determines current density, large areas of anodic metal and smaller areas of the cathodic materials should be sought. Thus, it is better to have steel sheets fastened with copper rivets rather than the reverse. Steel rivets were accidentally used in fastening monel sheathing on the yacht "The Sea Call". Failure of the steel rivets caused this vessel to be scrapped a few weeks after launching. These rivets had suffered from galvanic corrosion. The small and intense anode areas of the rivets had been surrounded by extensive cathode areas of monel.

The undesirable effects of galvanic action can often be prevented by the application of suitable paint coatings to metal surfaces. Painting of the anodic metal surfaces alone, however, is a very dangerous practice. This simply reduces the anode area and allows intense galvanic action to occur at any breaks in the paint film. When paints are used, the cathodic areas should always be painted and the paint films maintained on these areas. Cathodic areas are not damaged by galvanic action and, therefore, can be safely used in controlling the action.

Recently, a major automobile manufacturer painted steel radiator headers and soldered them to the usual copper radiator core. He was trying to conserve critical copper, but instead ended with a costly galvanic corrosion problem. Leaks developed in these radiator headers. The extensive noble metal areas of the copper core, metallically connected to the limited anode areas resulting from breaks in the paint coating, caused an active galvanic cell. A galvanic cell of lower intensity would have been obtained if no paint had been used on the steel headers.

Recall and replacement of the defective radiators on over 200,000 automobiles was necessary. This replacement job has been estimated by the manufacturer to cost $20 million.

The Galvanic Series

Metals are either anodic or cathodic, with respect to other metals with which they are associated. No metal has an absolute or inherent value of potential. Potential is a relative property. The potential of a metal is determined by the environment conditions and the specific metal or metals used as a basis of comparison. The environment conditions must always be stated, because under different environments reversed potential conditions can be encountered between two metals.

There is always a demand for a quick answer to the relative potential characteristics of two metals. The best guide is to arrange the various metals in accordance with their most often encountered relative characteristic. This is not the "Electromotive Series", which uses hydrogen as a standard of comparison, and which is so valuable in physical chemistry and thermodynamic studies. It is a series showing the more common galvanic relationships of commercial metals (see accompanying chart).

Metals grouped close together in the chart have no strong tendency to produce galvanic corrosion on each other. Yet the coupling of metals from widely spaced groups generally

results in strong galvanic cells. In most instances the metals from the highest position would be corroded or damaged.

Attention is called to the double listing of stainless alloys. In one case they are designated as "active" and in the other "passive". These conditions are not controlled by the manufacturer, but by environment. The stainless alloys, under certain conditions of service, act like the noble metals and are called "passive". Yet slight changes in those conditions cause them to act like ordinary iron so far as galvanic corrosion is concerned and they are then called "active" rather than "passive". Instances have been reported in which chromium-nickel-molybdenum alloys have been observed to have not two, but three different positions relative to another metal in the galvanic series. It is not generally known that similar alterations are possible with other metals.

Zinc is often used as a galvanic anode to confer cathodic protection on equipment. Zinc coatings in galvanized hot water tanks will be anodic and protect the steel tank provided temperatures do not get too high. If a heater is operated near the boiling point of water, however, a reversal of the usual galvanic relationship occurs. The zinc becomes the cathode and is surrounded by smaller anodic areas of the underlying steel. The dangerous condition of small anode and large cathode areas is thus encountered. The extensive galvanized surface acting as a cathode and a few spots of exposed iron acting as anodes result in premature perforation of the hot water tank.

Attention has been called to common chemical construction materials that undergo potential shifts. These shifts are usually in a more active or anodic direction and account for the sudden failure of these materials in many environments. A word might be given at this point concerning lead. It is rarely a factor in galvanic corrosion because it becomes covered with electrically inert sulfate films. In any case, shifts in potential of lead are in a more noble or protected direction and thus galvanic failures of lead are avoided.

Positive and Negative

In the above discussion it may have been noticed that sign conventions of "positive" and "negative" have been completely avoided. This has been done intentionally in order to prevent confusion. It is unfortunate that the Electrochemical Society and the U. S. National Bureau of Standards called platinum "positive" to magnesium, whereas members of the American Chemical Society called platinum "negative" to magnesium. Because of this confused situation, it is strongly urged that readers use the term *anodic* and *cathodic* rather than positive and negative in their discussions and thinking. Platinum is always cathodic to magnesium. The cathode is the protective member of a couple, whereas oxidation or corrosion occurs at the anode.

Galvanic corrosion can be halted if the metallic path between the anodic and the cathodic reactions is broken. Gas companies are now isolating their steel distribution lines from contact with the lead and copper water services. These lines of steel and copper are generally tied together in a galvanic cell through the hot water heater. Gas companies are now installing insulating couplings at their meters in order to break this galvanic cell.

Another experience is important enough to justify recounting. A seaplane was moored to a steel pontoon U-dock. The mooring pendants used were of steel instead of the usual manila line because of the strain anticipated during engine tests. The results were galvanic action between the steel dock and the aluminum pontoons. Considerable corrosion of portions of the hull nearest to the dock and peeling of paint were encountered. Steel mooring pendants used by the Navy now contain current interruptors in order that the metallic paths forming these galvanic cells will be broken.

Galvanic action can be prevented by the use of sprayed metallic, hot dipped and electroplated coatings. It is safer to work with the cathodic material and coat it with a more anodic metal. Galvanizing and cadmium plating are steps in the right direction. The failure of decorative chromium plating is an example of the reverse situation. Here the pores in the chromium plate allow small areas of iron, the relatively anodic metal, to be exposed and unsightly staining results.

In recirculating systems, inhibitors can also be used to control the destructive effects of galvanic cells. Let us return to the automobile with its large area of copper as found in the radiator. This is connected by rubber hose to less extensive areas of cast iron or aluminum in the cylinder assembly. This rubber hose does not

The Galvanic Series

Corroded End (Anodic or Least Noble)

Magnesium
Aluminum

Zinc
Cadmium

Iron or steel
Stainless steels (active)

Soft solders
Tin
Lead

Nickel
Brasses
Bronzes
Nickel-copper alloys
Copper

Stainless steels (passive)
Silver
Graphite
Gold
Platinum

Protected End (Cathodic or Most Noble)

Ways to Prevent Damage by Galvanic Corrosion

(1) Keep the anode area more extensive than that of the cathode.

(2) In applying coatings and barriers of other metals, work with the cathodes first so that damaging effects will not be accentuated.

(3) Break metallic connections or paths wherever possible.

(4) Specify anodic coatings.

(5) Add inhibitors to recirculating systems.

(6) Beware of generalizations from the Galvanic Series, which is based on ideal laboratory conditions.

(7) In a galvanic couple that can't be avoided, don't use anodic metals for the critical structural material.

(8) Use sacrificial anodes of zinc and magnesium in order to have the galvanic cell work to your advantage in giving cathodic protection to critical equipment—even if only hot spot protection is obtained.

isolate the copper from the block if the radiator and engine are attached to the car frame by simple bolting. Again, there is a common electrolyte, in contact with two different metals, that are tied to each other through the car frame. The galvanic cell could be broken by insulating the radiator from the car frame, but this is not practical. In this particular problem, inhibitors provide an ideal solution because of the recirculating nature of the coolant.

The financial reports of a well-known fire extinguisher manufacturer show that $1,225,000 were charged directly to corrosion losses. These corrosion losses occurred because of the use of fire extinguisher fluids that corroded the valve components of the extinguishers and caused them to jam. A total of 500,000 fire extinguishers were recalled and replaced by new ones with a fluid containing an inhibitor.

A large number of compounds act as inhibitors. When these compounds are to be added as a part of regular process operations, add them early in the process in order to obtain the benefit of their inhibitive effect.

Cathodic Protection

Specifically designed galvanic anodes of zinc and magnesium are in use now to protect steel surfaces from the corrosive action of soils and waters. Cathodic protection is obtained by electrically connecting these pieces of expendable anode to the critical structure requiring protection.

Historically, in 1761 the British Admiralty observed beneficial effects which could be obtained from galvanic protection of exterior ship hull components. In this instance the couple involved copper and iron. There is a record of Sir Humphry Davy's interest in galvanic cells involving zinc, iron and copper, and the literature today contains numerous references to work done in attempting to apply cathodic protection to ship hull surfaces.

As an indication of acceptance in the field, most ships operating in American waters have zinc anodes attached to their stern frame members. The commercial availability of magnesium, a metal more anodic than zinc, has opened a new field for the cathodic protection of hull surfaces. Rapid strides are now being made in the more effective use of both zinc and magnesium anodes for the protection of exterior hull surfaces of ships, piers and pipelines, as well as condensers and water heaters.

Corrosion prevention is important on the large transcontinental pipe lines which bring oil and gas from Texas to the East. For example, a 30-in. pipe line has only a 5/16-in. wall thickness. The overdesign of this wall thickness by only 1/16 in. would add 92,000 tons of steel and increase the original investment in the order to $20 million (using 1950 prices). Yet, if no other protection is added, increasing the wall thickness only delays, temporarily, the appearances of leaks and corrosion damage a short time.

Current design practices are such that loss of 1/16 in. of the parent metal of a 5/16-in. pipe line would result in its operating at 100% of the yield strength of the metal. Corrosion is controlled on these lines by coatings to reduce the cathode areas and then by placing sacrificial pieces of magnesium or zinc in metallic contact with the line in order to protect or counteract the anode areas. The corrosion is thus diverted to noncritical and expendable anodes. If corrosion can be controlled on pipe lines extending more than a thousand miles in length, there seems little excuse for the failures in piping that occur repeatedly in our plants.

Many plants are now installing sacrificial anodes in a routine manner when repairing leaks in their utility and service lines. A leak is the most reliable way of knowing that protection is needed in a given area, even if it is repaired. Sacrificial galvanic anodes installed during the repair provide the least expensive type of protection obtainable. Protection of this type is called "hot spot" protection. If enough sacrificial metal is installed, galvanic corrosion will be completely arrested. If insufficient current is obtained from the sacrificial metal, full protection will not be obtained, but the rate of corrosion will be reduced.

In the transportation of petroleum products, an empty tanker isn't very sea-worthy and, therefore, corrosive sea water is added as ballast to some of the tanker cargo compartments. Can you imagine a more severe corrosion condition than that which exists when volatile solvents and sea water are alternated as cargo in a tanker? The volatile solvents dissolve all but very special types of paints and are discharged at the marketing areas. The tanker then returns for another load of its valuable petroleum products using sea water as ballast. As a measure of the severe corrosion stress under which these tankers are operated, 140 tons of scale representing 100 tons of corroded iron were removed from the ballast tanks of a tanker that had been in operation only eight years.

A practical solution to the severe ballast tank corrosion problem has been found in the use of cathodic protection with sacrificial magnesium anodes. This has followed the principle developed commercially in the field of buried structures; namely, in the pipe line industry. In both cases magnesium anodes are distributed along the surfaces to be protected. They are spaced a relatively small distance from the structure, but maintained electrically in contact with it by means of connecting lead wires or other devices. Whenever an electrolyte is present, such as sea water ballast, the galvanic cell of the expendable magnesium anodes and the steel structure become active.

The primary advantage of a cathodic protection system using galvanic anodes over other corrosion control methods is its simplicity of installation and operation. The entire operation of the system is controlled by the semi-permanent installation of anodes and the presence of an electrolyte, in this case ballast water. There are no moving parts or other devices that require attention. Merely filling a compartment with sea water activates the system, which then remains operative until the electrolyte is removed.

These same principles are now being applied to the protection of exterior hull surfaces of ships and steel pilings of piers and off-shore drilling platforms. Whenever there is an electrolyte present, cathodic protection offers a possible solution for controlling the associated corrosion problems.

References

Francis L. Laque, *ASTM Transactions*, 1951, Edgar Marburg Lecture.

Wall Street Journal, Jan. 10, 1952, p 1.

W. E. Pratt and E. T. Collinsworth, *Corrosion*, Vol 5, p 39, 1949.

U. R. Evans, "Metallic Corrosion Passivity and Protection", Edward Arnold & Co., London. 1937.

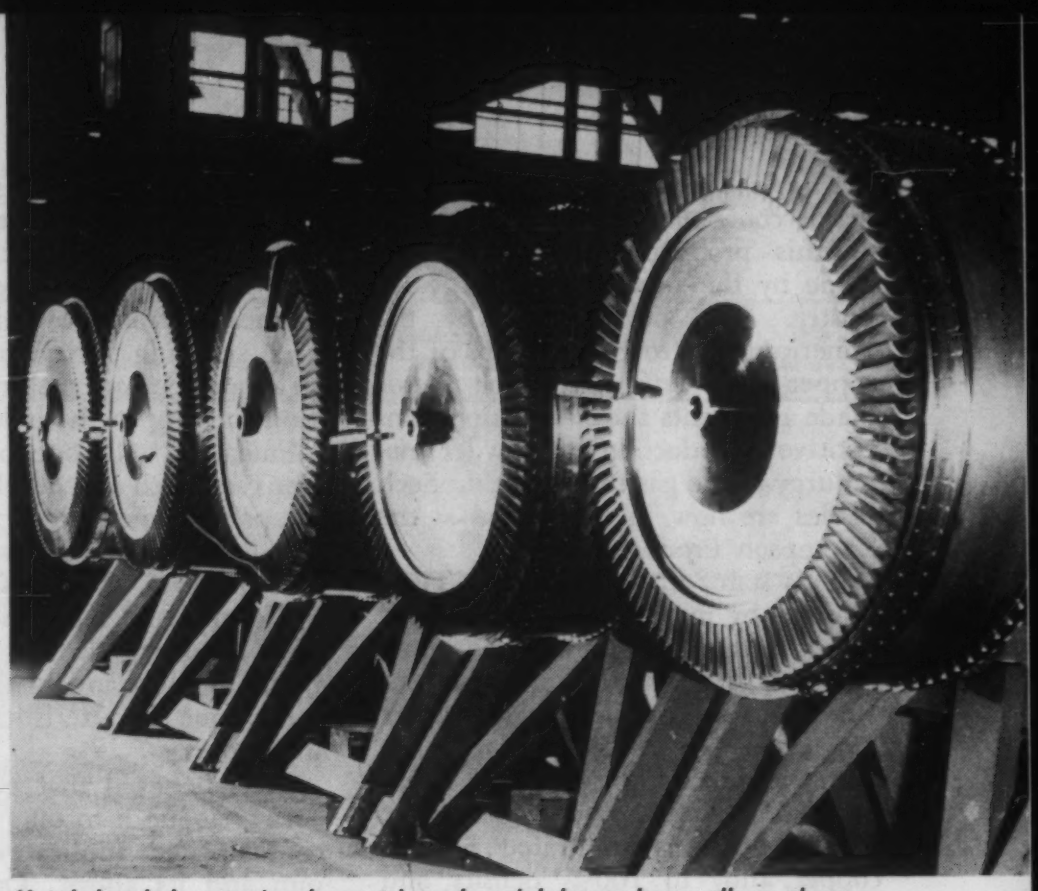
A. W. Peabody, "Designs for Corrosion", American Gas Assn. pub. DMC-52-6.

N. E. Promisel and G. S. Mustin, "Prevention of Corrosion in Naval Aircraft", *Corrosion*, Vol 7, 1951.

Annual Reports, Pyrene Manufacturing Co., Newark, N. J., 1947-1949.

Clyde McGraw, "Why We Incorporate a Corrosion Control Program in the Early Stages of Construction of Modern Gas Transmission System", American Gas Assn. pub. DMC-51-2.

Turbine guide vanes are another potential application of sintered powder parts.



Metal bonded ceramics (cermets) and molybdenum-base alloys show considerable promise as turbine blade materials.

Powder Metallurgy Parts in High Temperature Applications

by **Julius J. Harwood,** Deputy Head, Metallurgy Branch, Office of Naval Research

Development and use of copper infiltrated iron, titanium alloy powders, sintered aluminum powder, molybdenum-base alloys and "cermets" are being hastened by shortages and service limitations of our present high temperature alloys.

● THE PRESENT MILITARY rearmament program has delineated two major problems with respect to materials for high-temperature service. The first is the limited availability of cobalt, columbium, nickel and other alloying elements which make up our commercial heat resistant alloys. The second problem is the temperature limitations of our commercially available high temperature alloys. Fuels are available to provide the necessary operating temperatures for more powerful, more efficient gas turbines of greater thrust, but our present blading materials do not retain useful engineering properties at temperatures exceeding about 1600 F.

The urgent need for conservation of our critical alloying elements has led to the development of leaner alloy composition for gas turbines now in production. The need for materials of superior high temperature strength properties is being approached through development of new refractory alloy systems, development of metal-bonded refractory compounds commonly called cermets and development of materials useful for artificial cooling techniques, *e.g.* permeable materials for sweat cooling. In all of these various developments, powder metallurgy methods and techniques are playing significant and important roles. In the last two approaches mentioned, powder metallurgy may hold the only key, since at the present time the materials being developed can be fabricated into useful shapes solely by powder metallurgy methods.

Jet Compressor Parts

An axial flow type jet engine requires 2000 to 3000 compressor blades. In the event of full scale mobilization, millions of blades per month would be required. Since forged stainless steel was, until recently, the major compressor blading material, it is obvious that serious production and strategic material problems would be involved.

This paper represents only the personal views of the author and in no way reflects the official attitude of the U. S. Navy

Copper Alloy Infiltrated Iron—A major contribution to the alleviation of this problem already has been made by the powder metallurgy industry. The development by the American Electro Metal Corp. of the copper alloy infiltrated iron stator blade represents the first major competitive introduction of powder metallurgy in the gas turbine field. Such blades are now in production at the Thompson Products Corp.

This stator blade, known as TP-1, is made by molding iron powder by means of a multiple action die into a preform shape. The preform is sintered and then coined to the exact dimensions of a compressor blade with the thin trailing edge and thicker leading edge. After coining, the porous blade is infiltrated with a copper alloy to 100% density and heat treated to develop the required strength properties. Tensile strengths of 90,000 psi with elongations of 8% have been reported.

The TP-1 blade is now being used as a standard compressor stator blade in at least one industrial gas turbine and is performing satisfactorily in service. It has been tested for use as a rotor blade material, for which the strength requirements are higher, and indications are that it may prove satisfactory for such applications also. Research is now underway under military sponsorship to improve the high temperature strength and impact properties of this material by appropriate alloying additions in order to make it usable for newer engine designs which have more severe material requirements.

Titanium Alloys—Another metal system that is entering the field of compressor materials is based on titanium alloys. Titanium alloys are being used in limited production by Westinghouse Manufacturing Corp. as compressor disk materials to replace type 410 stainless steels. These disks operate at a temperature greater than 350 F, and it is estimated that an appreciable weight saving will result from such a substitution. Titanium alloys are also being evaluated for use as compressor blade materials, and the indications are that they may be satisfactory for the first few compressor stages.

These applications are currently making use of wrought materials, but the contributions of powder metallurgy to the development of the titanium industry must not be overlooked. Because of its extreme reactivity in the molten state with all known crucible and mold materials and because of the necessity for using inert atmospheres to prevent gas contamination and embrittlement, titanium and its alloys were originally fabricated from powder by pressing and sintering techniques. The development of arc melting and induction melting methods has practically eliminated, with one or two exceptions, research and development work on powder metallurgy processing of titanium. It is worthwhile to point out, however, that considerable nonuniformity and fabrication difficulties have been experienced with arc cast titanium alloy ingots as a result of the unique characteristics of the melting process.

It is believed that powder metallurgy has much to offer in numerous contemplated applications for titanium and its alloys. One early disadvantage of pressed and sintered compacts was the relatively low endurance limit/tensile strength ratio. Compared to arc melted stock, which exhibited a ratio of 0.5 or higher, powder metallurgy samples displayed ratios of 0.3. This difference appears to be directly attributable to low density in the latter specimens. Methods have been developed by at least one industrial concern for pressing titanium compacts to theoretical density, and recent tests have indicated that such compacts exhibit properties equivalent to that of arc melted material. For example, a high purity titanium sponge consolidated by powder metallurgy techniques gave the following average values:

Tensile Strength	48,000 psi
Elongation	33%
Hardness	Rockwell B 65-70
Fatigue Strength	24,000-25,000 psi at 8×10^8 cycles—no failure

$$\frac{\text{Fatigue Strength}}{\text{Tensile Strength}} = 0.5$$

The Brush Development Co. has developed a method for the production of titanium powder from sponge material. No significant contamination is experienced in the powdering process. Compacts consolidated from such powder exhibit tensile strengths ranging from 65,000 to 85,000 psi with average elongations of 20 to 25%. The strength and elongation properties are, of course, functions of the purity of the powder.

An excellent example of the use of powder metallurgy methods in appropriate applications is a titanium filter developed by the Brush Development Co. for the Fram Corp. for applications involving fuming nitric acid. The filter has a density of 50% with a permeability of 30 to 50%. Its corrosion resistance in 98 to 99% fuming red and white nitric acid at 160 F is less than 0.5% after 700-hr immersion. Type 316 stainles steel filters under similar tests were totally disintegrated in four to seven days. The filters are pressed in two separate halves, and then two plates are joined together at the edges.

It seems reasonable that other applications exist for titanium alloys for which appropriate use of powder metallurgy processes can solve alloy and fabricating problems. For certain shapes, appreciable cost reduction can be an important contribution also. The present price of titanium sponge is about $5.00 per lb. In the form of wrought products, *e.g.* sheet or plate, the price of titanium

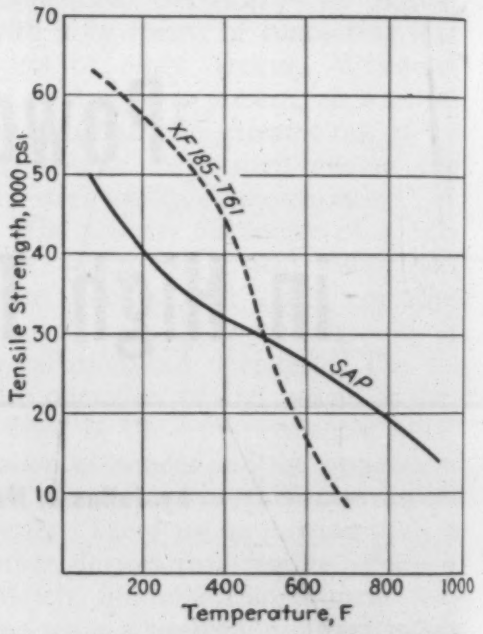
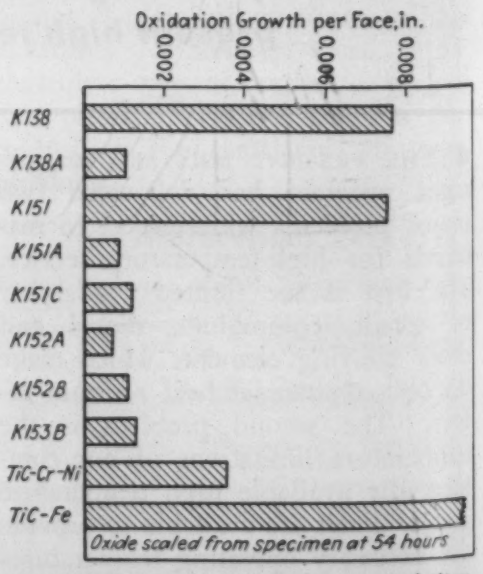


Fig 1—High temperature tensile properties of sintered aluminum powder (ASP) and aluminum alloys.



Oxidation characteristics of cemented titanium carbide compositions. (Kennametal Inc.)

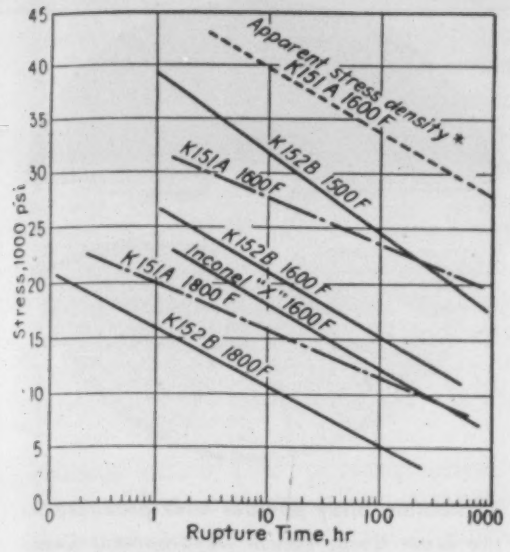


Fig 3—Stress-rupture properties of cemented titanium carbides. (Kennametal Inc.)

Apparent stress density=
stress K151A x dens. Inconel X
density K151A
(Applicable to rotating parts where centrifugal stresses at any one speed are proportional to density.)

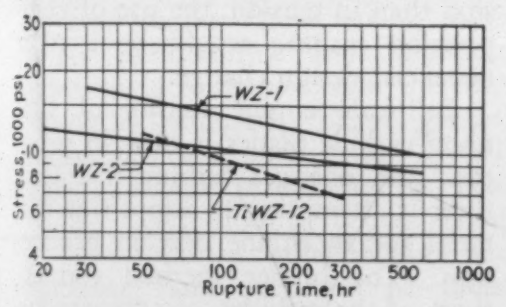


Fig 4—Stress-rupture properties at 1800 F of titanium carbide compositions using chromium-nickel or chromium-cobalt binders. (American Electro Metal Corp.)

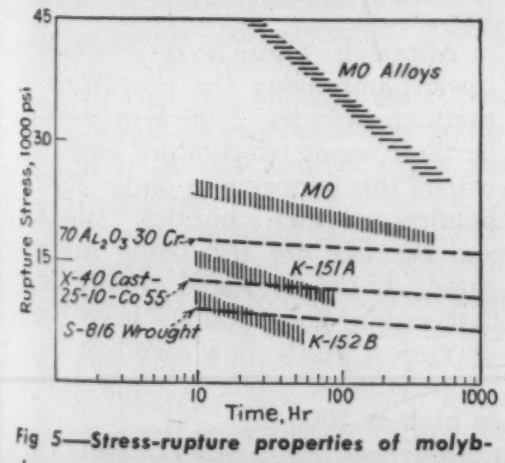


Fig 5—Stress-rupture properties of molybdenum and molybdenum alloys at 1800 F compared to other high temperature materials.

alloys jumps to $20 to $30 per lb. By resorting to direct pressing methods, and thereby omitting the cast ingot stage, it seems conceivable that this price could be reduced substantially. In addition, as is now the case with molybdenum and beryllium, titanium ingots of substantial sizes

Room and High Temperature Strength Properties of Sintered Aluminum Powder

Temp F	Tensile Strength, Psi	Yield Strength, Psi (0.2% Offset)	% Elongation
72	50,000	34,200	10
212	40,000	34,000	10
392	32,800	30,530	8
752	21,300	20,600	4
932	14,200	13,500	2

and weights should be able to be produced by powder metallurgy methods using hydrostatic pressing techniques. It must be noted that any high temperature operations with titanium, such as sintering, must be done under vacuum or inert atmospheres.

Sintered Aluminum Powder—An interesting Swiss development is that of a strong, high temperature aluminum "alloy" called SAP—Sintered Aluminum Powder. This new sintered aluminum product shows potentialities for use at temperatures of 800 F, a 400 F increase over the best commercial high temperature aluminum alloy. SAP is produced by cold pressing aluminum powder of fine particle size into briquettes under a pressure of 20 to 50 kg per sq. mm, sintering the briquettes at temperatures of 900 to 1100 F, followed by further hot pressing under 50 kg per sq mm, and finally extruding the material into rods. The density of the rods is 2.8 g per cu cm. SAP rods can be further cold or hot worked into sheets, shapes or drop forgings.

The powder is produced by the Hametag process in an atmosphere low in oxygen. The shapes of the particles are flakes or lamellae with a particle size of 1—100 angstroms, with about 50% of powder below 2 angstroms in one dimension. As with most powder metallurgy products, the finer the particle size the greater the mechanical properties of the final product. From the standpoint of metallic impurity, SAP is equivalent to commercial 2S aluminum, but it contains between 10 and 20% by weight of oxide. Presumably each particle is surrounded by a layer of aluminum oxide.

Exposure to temperatures as high as 900 F for as long as 100 hr results in little or no change in the room temperature tensile properties. The room and high temperature tensile properties of SAP, as taken from a Swiss report, are shown in the Table. Fig 1 compares these properties with those of one of our best high temperature, age hardenable aluminum alloys, RR58 (XF18S-T61). In general, it can be stated that the strength and creep resistance of SAP at 600 F are as much as 2 to 5 times greater than those of conventional aluminum alloys. In addition, the fatigue properties of SAP are generally superior to those of aluminum alloys at temperatures greater than 400 to 500 F.

Some other characteristics of SAP are as follows:

1. SAP shows 80% of the thermal expansion, 78% of the thermal conductivity, and 70% of the electrical conductivity of pure aluminum.
2. It has as good sea water corrosion resistance as pure aluminum when made of pure aluminum powder.
3. It can presently be produced in sizes up to 6 in.

Several industrial concerns are experimenting with SAP for component applications in standard engines, and in view of its high temperature strength properties, consideration is also being given to its use as a compressor blade material. The making of finished shapes by direct hot pressing appears as a promising feature of this material.

Turbine Wheels

A major share of our high temperature materials research and development effort is directed at the turbine stage of jet engines, since this is where potential gains in performance can be achieved.

Turbine wheels are composed of turbine disks and turbine blades. At present, the blades are either welded or mechanically fitted into the disk. Turbine blade materials must have high oxidation and erosion resistance, high creep and rupture strength over a range of temperature, high fatigue strength at operating temperatures, and resistance to thermal shock.

Three different approaches to the turbine blade materials problem offer

considerable promise and are currently the subject to comprehensive research programs. These are the development of cermets (metal bonded refractory compounds); the development of transpiration cooled (sweat cooled) blades; and the development of molybdenum-base alloys. In all of these, powder metallurgy is playing an important role.

Cermets—In the field of cermets, metal bonded carbides, borides, nitrides, aluminides, silicides and oxides are being investigated. These types of materials at the present time can only be fabricated into useful shapes by powder metallurgy methods. Procedures commonly used are conventional pressing and sintering operations, hot pressing, hydrostatic pressing methods using oil and rubber bags, rubber molding techniques to obtain uniform densities, or extrusion methods using a fugitive plasticizer.

One of the most promising cermets is the cemented titanium carbide compositions. These metal bonded titanium carbides exhibit strength properties up to 1800 F, and oxidation resistance and thermal shock characteristics which make them potentially useful turbine blade materials for present day engines and which hold out a real hope for boosting turbine operating temperatures several hundred degrees.

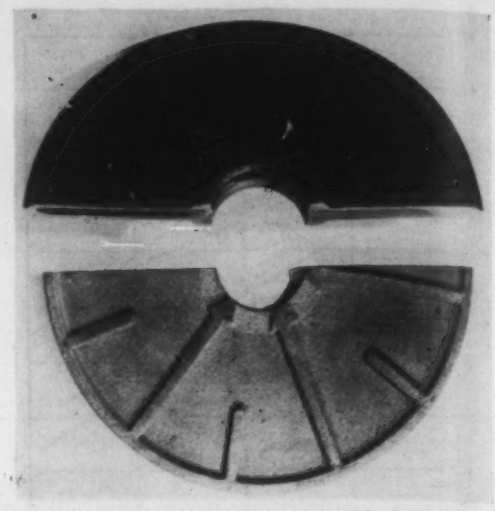
A variety of metal-bonded titanium carbide compositions has been developed in this country by Kennametal, Inc. The most interesting grades at present employ a nickel binder and are being marketed as Kentanium K151A and K152B. K151A contains about 20% nickel as a binder and some mixed solid solution carbides of tantalum and columbium. K152B also contains tantalum-columbium carbides and has a binder content of 30% nickel. The addition of the mixed solid solution carbides enhances the oxidation resistance of titanium carbide. The oxidation characteristics of the carbide are shown in Fig. 2. Note the marked decrease in oxidation rate upon the additions of tantalum-columbium carbides as contrasted by the results for K151 and K151A. Indications are that titanium carbide compacts can satisfactorily resist oxidation at temperatures up to 2200 F.

The stress-rupture curves of titanium carbide compositions are shown in Fig. 3. Above 1500 F the high temperature strength properties are comparable to or superior to those of many currently used alloys, even when density is not considered. Since the carbides have densities ranging from about 5 to 68 per cc, or 2/3 that of our present alloys, the centrifugal stresses developed would be proportionately lower.

On a strength/density basis, the high temperature properties of titanium carbide compositions are superior to those of many alloys by a substantial factor. Recent work with nonstrategic binder modifications indicate that the high temperature strength properties can be increased even further—possibly by as much as two times. Work in Europe also has led to the development of cemented titanium carbide compositions with equivalent high temperature properties. The European grades contain chromium-nickel or chromium-cobalt materials in amounts up to 40%. These materials are now being marketed by the Firth Sterling Steel and Carbide Corp., in conjunction with the American Electro Metal Corp. Transverse rupture strength of these carbides at room temperature range between 175,000 and 225,000 and at 1800 F from 125,000 to 150,000. The 100-hr stress rupture life at 1800 F is 14,000 psi (Fig 4).

Thermal shock resistance is an important requirement for turbine blade materials. Tests conducted by the National Advisory Committee for Aeronautics, the Navy and the Air Force revealed that titanium carbide compositions have satisfactorily withstood laboratory and simulated engine thermal shock tests by rapid quenching from temperatures as high as 2400 F. Fatigue tests, run at about 1400 F, indicate that metal-bonded titanium carbide has a ratio of fatigue strength to tensile strength of about ½. This compares favorably with many high temperature alloys at the same testing temperature. For 50 x 10^6 cycles, a fatigue strength of about 30,000 psi was found.

Titanium carbide turbine blades, fabricated according to present designs, have run satisfactorily in engine tests for over 100 hr. This is significant, considering that present blade designs are far from suitable for the use of brittle materials. Many failures were encountered in early trials because of stress concentrations in blade root attachments. The NACA is making a comprehensive study of this problem, and new designs are being developed to overcome the lack of room-temperature ductility of the carbides and other cermet materials. The ultimate use



A titanium alloy powder filter produced for the Fram Corp. (Brush Development Corp.)

of these non-ductile materials will depend upon design innovations that will avoid their deficiencies and make maximum utilization of their strength properties. Since these materials are much stronger in compression than in tension, the use of compression loading would be a most beneficial design change.

Full-scale engine testing of titanium carbide blades is now in progress, and one gas turbine manufacturer is attempting to adopt this material for an engine now in production. The higher thermal conductivity of the carbides, as compared to conventional high temperature alloys, will undoubtedly lead to higher turbine disk rim temperatures. Metal-bonded titanium carbides can be fabricated into a variety of shapes by direct pressing, extrusion or machining.

Although research is continuing toward improving the properties of titanium carbides, 2200 F appears to be their upper temperature limit. To extend this temperature range- metal-bonded nitrides, borides, silicides and the like are also being investigated. It can be stated at this time that several compositions have been developed which show excellent high temperature strength at temperatures as high as 3000 F.

Materials for Sweat Cooling—A novel approach to the turbine blade materials problem involves the use of artificial cooling systems so that the blade is maintained at a temperature appreciably lower than that of the gas. One of the most efficient methods for accomplishing this objective is the use of transpiration, or sweat cooling, as it is more commonly known. Transpiration cooling consists of forcing a stream of coolant, either gas or liquid, through a porous body, in a direction opposite to

the heat flow. The cooling medium gradually increases in temperature while passing through the porous body and finally reaches the inner wall surface, where it forms a protective layer. Sweat-cooling has been shown to yield larger temperature drops than any other method of cooling which has been investigated.

The applicability of sweat cooling opens up new fields in powder metallurgy by extending the range of application of porous metals. With respect to turbine applications, sweat cooling offers two possible advantages. Less strategic alloy compositions can be used in present engines, since the blade temperature can be reduced to 1100 F or lower; or the gas temperatures can be raised appreciably with continued utilization of present turbine blade materials, which can operate at temperatures up to 1600 F.

The major problem involved is to develop porous alloys having maximum permeability and minimum porosity in order to obtain the high strengths required. Three general techniques are now being investigated for the preparation of controlled permeability bodies—loose powder sintering, cold pressing and sintering, and extrusion of metal powders using plasticizers or carriers. The latter technique has been developed to the point where rough blade shapes already have been prepared, and it is hoped that during the next year a turbine wheel fully bladed with permeable turbine blades will be available for dynamic testing. Stainless steel powders are being employed in this initial work and bodies can be produced with permeabilities, in the desired range and with satisfactory strength values. A 500-hr stress rupture value of 20,000 psi can be obtained with a permeable compact made from type 316 stainless steel powder, with an elongation of 3 to 6% at time of failure.

Molybdenum-Base Alloys — A third most promising approach has been the development of molybdenum-base alloys for high temperature application. Because of its high melting point, its known high temperature properties, and its availability in this country, molybdenum has been selected as the most promising of the refractory metals for super high temperature service. Powder metallurgy techniques have advanced to the stage where sintered and pressed molybdenum shapes measuring up to 6 in. sq, 4 ft long and weighing over 400 lb are not uncommon. Hydrostatic pressing techniques have made feasible the production of powder metallurgy ingots weighing up to 700 lb.

At temperatures above 1600 F, the creep and stress-rupture properties of commercially pure molybdenum are superior to those of any of our high temperature alloys, which are either cobalt-, iron- or nickel-base alloys (Fig. 5). These high temperature properties vary considerably with the source of molybdenum powder, purity of powder, method of consolidation, fabrication history and other factors. Comparison of properties of different molybdenum samples is apt to be misleading unless the specimens have received equivalent amounts of work or are in comparable states of recrystallization. A recent comparison of the properties of arc cast and powder metallurgy specimens revealed equivalent properties when the mtallurgical history and structure of the samples were equivalent.

In order to obtain superior high temperature strength properties, parallel research programs are underway for the development of molybdenum-base alloys by both arc melting and powder metallurgy techniques. Alloys have already been developed which show outstanding stress rupture properties. The recrystallization temperatures of some of these alloys are about 1000 F higher than for commercially pure molybdenum.

Several obstacles still must be overcome before molybdenum alloys can receive widespread military application. Satisfactory protective coatings are needed to prevent the rapid oxidation which molybdenum and its alloys undergo. Certain brittle characteristics which cause welding, fabrication and service difficulties must also be overcome. Molybdenum turbine blades are now being developed by Thompson Products Co., and latest reports indicate that such blades coated with protective coatings have been run in engine tests for over 100 hr.

Adapted from a paper delivered at the Eighth Annual Meeting of the Metal Powder Assn., Apr. 1952.

References

G. Stern and J. A. Gerzina, "Making Jet Engine Compressor Blades by Powder Metallurgy." *Iron Age, 165,* 74, Feb. 1950.

J. J. Harwood, "New Structural Metals." *Product Engineering,* p. 96, Oct. 1950.

(a) A. von Zeerleder, "Sintering of Aluminum Alloys." *Zeit fur Metallkunde, 41,* 228 (1951).

(b) R. Irmann, "Sintered Aluminum of High Heat Resistance." *Revue de l'Aluminum,* 28, 269, July-Aug. 1951 and *28,* 311, Sept. 1951.

(c) R. Irmann, A. von Zeerleder and F. Rohner, "Properties of Hot Pressed Sintered Articles of Aluminum Powder (SAP)", *Leict. Metall. 3,* Jan.-Feb. 1950.

(a) J. C. Redmond and J. W. Graham, "Field of Cemented Carbide Expanded by Titanium Compositions." *Metal Progress, 61,* 67, Apr. 1952.

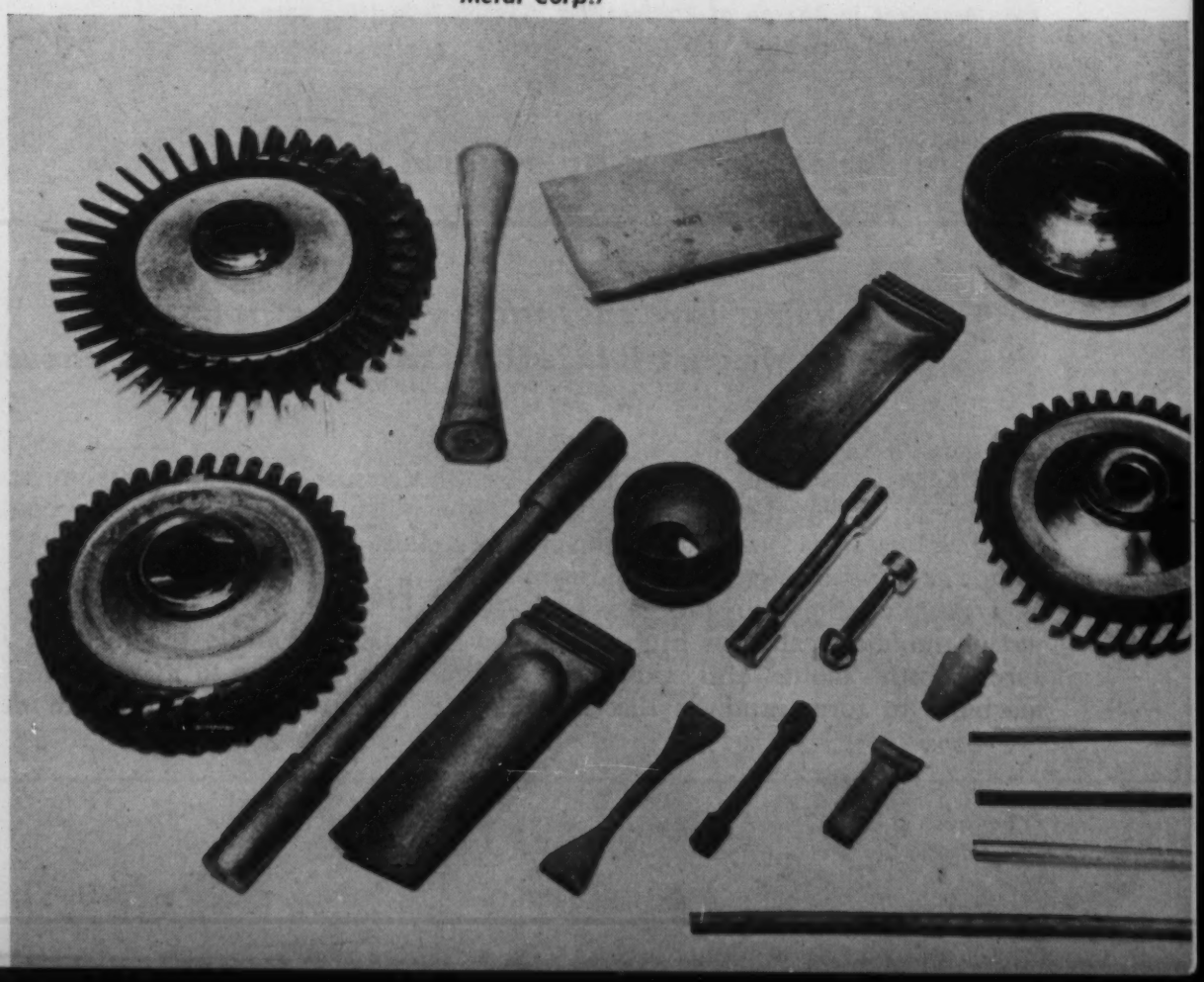
(b) "Kentanium," Kennametal Inc., Bulletin 1051, Oct. 1951.

P. Duwez and H. E. Martens, "The Powder Metallurgy of Porous Metals and Alloys Having a Controlled Porosity." *Metals Technology,* Tech. Pub. No. 2343, Apr. 1948.

P. Duwez and H. L. Wheeler, "Experimental Study of Cooling by Injection of a Fluid Through a Porous Material." *J. Aeronautical Sciences, 15,* 509, Sept. 1948.

J. J. Harwood, "Molybdenum, Our Most Promising Refractory Metal." *Product Engineering,* p. 121, Jan. 1952.

A variety of shapes produced from metal bonded titanium carbides. (American Electro Metal Corp.)



PLASTIC BACKS to protect the ends of television tubes in Philco sets are formed from Royalite sheet.

Parts Formed Economically from Thermoplastic Sheet

by **GEORGE LUBIN**, Director of Research, and **MAURICE MARTIN**, Vice President in Charge of Engineering, Basson Industries Corp.

- ***Sheet forming by several methods is now feasible for long run production items.***

- ***By using low cost molds and equipment it competes with injection molding in many cases.***

● THE FORMING OF thermoplastic sheet has developed rapidly in the last few years. In some cases, it is competitive with injection molding as a plastics fabricating process. Injection molding calls for high pressures, costly molds and expensive machines to form products that can often be made with cheap air presses, low pressures and inexpensive molds by sheet forming.

The Process

In sheet forming, the material is heated in an oven to make it workable. The working temperature depends on the plastic, the sheet thickness, the forming method used, and shape of the part. The hot sheets can be formed in a drawing die, vacuum formed, stretch formed over a male mold, or ridge formed over a male or female mold. For high-speed forming, the molds are set up in presses up to about 10 tons in capacity.

Sheet forming used to be practical only for short run production of parts that could not be made economically in any other way. For certain products that require a good deal of manual manipulation in sheet forming, this is still true. For many parts, however, fast press production on relatively inexpensive molds (mostly made of wood) is possible. On short production runs, the steel molds required for injection molding can hardly be amortized economically. Even on runs of 50,000 or more parts, however, improved techniques, better mold design and the use of larger sheets have made sheet forming economical.

Typical Parts

A television tube back for Philco was formed from styrene copolymer sheet. This part protects the narrow end of the tube where it projects beyond the cabinet. By injection molding, it was estimated, 360 parts per hr could have been produced in a four-cavity mold in a 40-sec cycle. Twice as many units per hr—720—can be made by forming in a 30-cavity mold in a 2½-min cycle. The sheet forming mold was also much cheaper, of course. Finishing costs were also reduced since the formed part only needed a die punching while the injection molded part would have had to be deflashed and ground smooth. Sheet forming showed further savings in that the equipment did not have to be cleaned to change from one color to another, and the machine did not have to be broken in at the start of the operation.

Winchester Repeating Arms Co. replaced ten different-sized wood tote boxes for carrying gun stocks with a single box formed from styrene copolymer sheet. The plastic box holds the parts better and handles more easily on conveyors due to its design. Although the plastic tote box costs 4 to 5 times as much as a wood box, its life expectancy is 8 to 12 years, compared to 1 year for a wood box. The forming mold costs $500. An injection mold would have cost about

$35,000, making injection molding practical only for a very long run.

Many other parts have been successfully formed from sheet. Crash helmets, map and instrument cases, arm rests, battery electrolyte containers and scuff panels are examples. Most products are made in one piece, although it is sometimes better to mold a product in two parts, to be assembled by cement or mechanical fasteners.

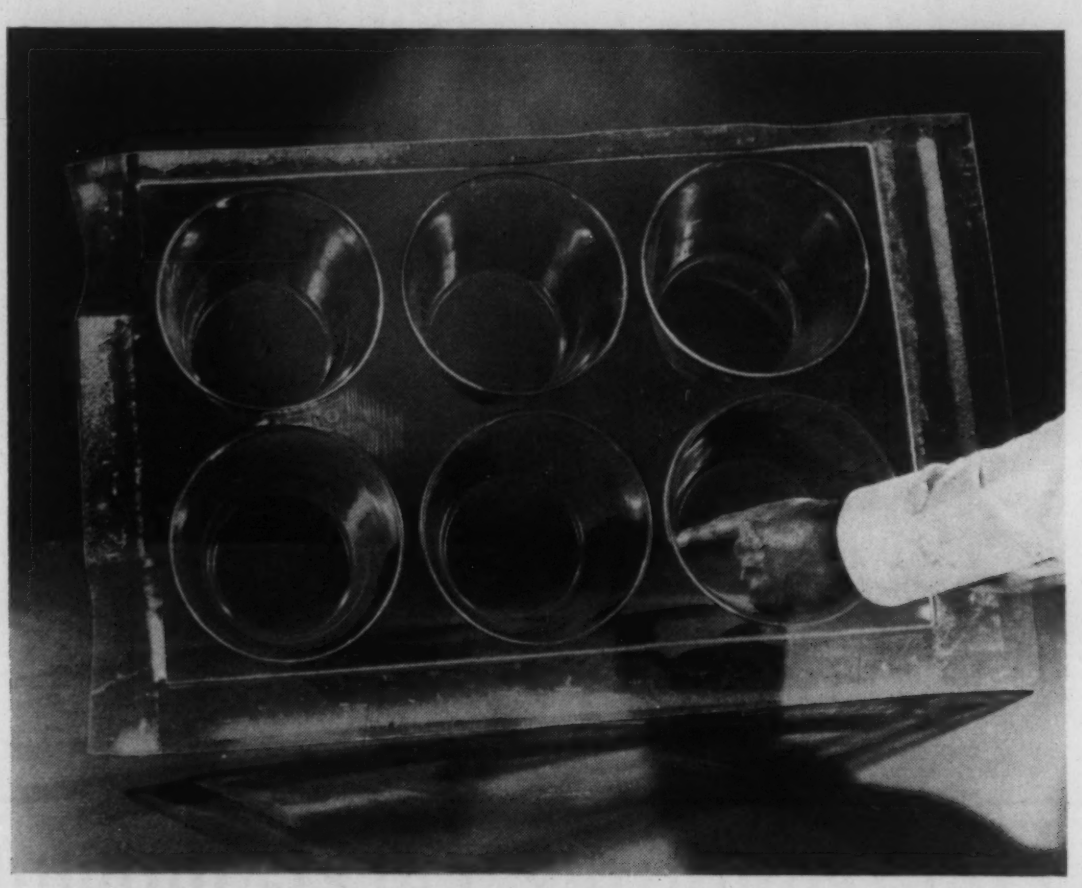
Factors to Be Considered

The first factor to be considered in a forming operation is whether the part can be made economically by this method. This includes consideration of wall thickness, undercuts, reinforcements, partitions, and the general design of the product. Experience often suggests means of adapting the technique to products for which it does not on first glance appear suitable. The sheet may be thinned out too much by an excessive draw. Re-design will often solve this problem, however. The Philco television tube back, for example, was redesigned in a step construction to reinforce the thin wall section. Some copolymer sheets can be stretched almost indefinitely, without tearing. While depth of draw is more limited with acrylic or vinyl, these plastics also permit a measure of design flexibility. In some cases, thin walls can be reinforced internally by cardboard or other cheap material. This is only a makeshift substitute for sound design, though. It is usually better to make the piece itself as strong as possible.

In deciding on the sheet area required, shrinkage must be considered. Shrinkage is especially important with calendered stock, but is also a factor with cast and laminated sheeting. Normally, thermoplastics shrink in only one direction, and only one linear dimension need be compensated for. Shrinkage can be decreased by restraining the sheet in a frame.

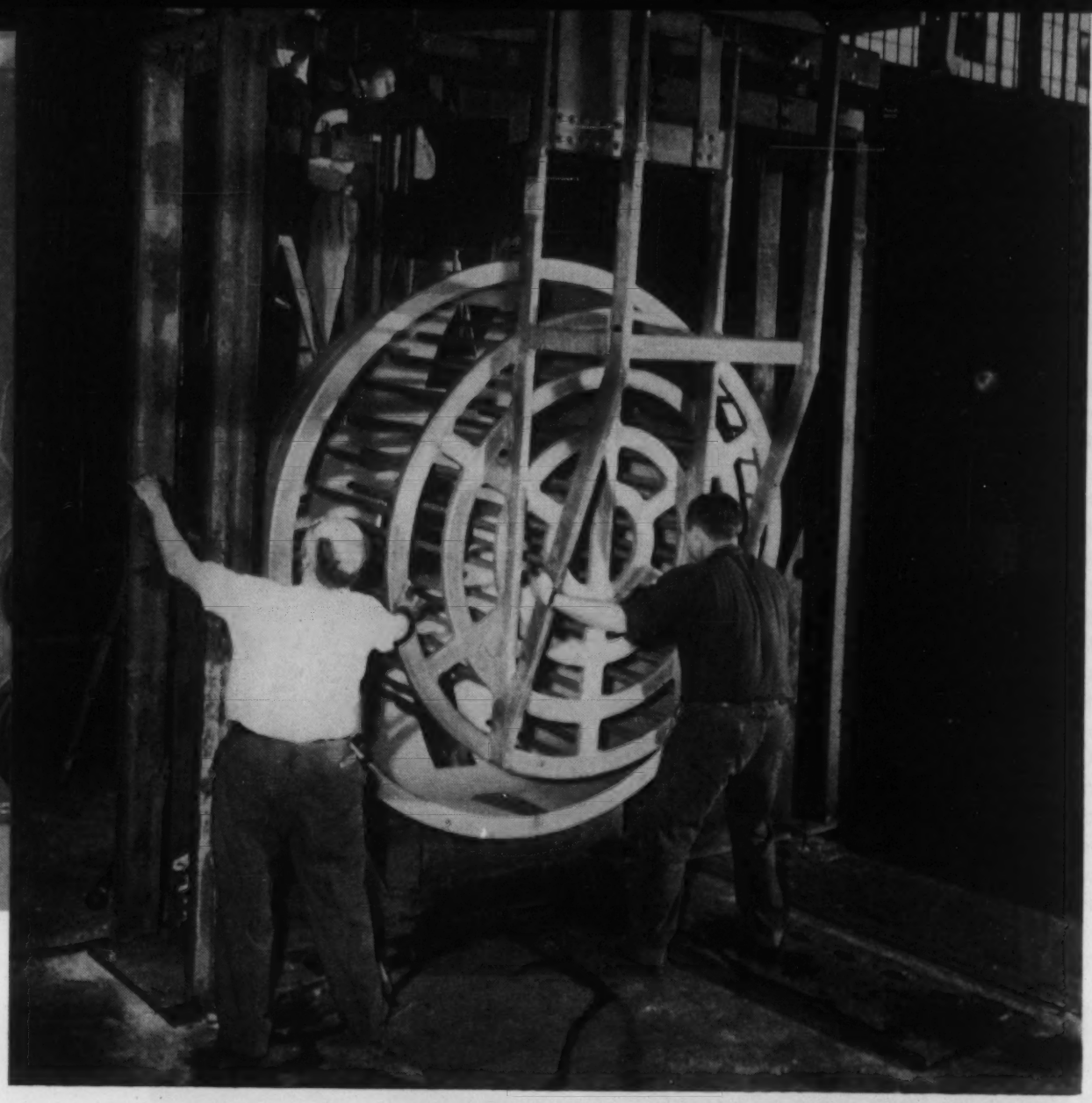
The most economical size of sheet should be chosen to give the least scrap and form the maximum number of sheets at a time. In general, the larger the sheet, the more economical the operation. In the past, sheet forming was usually a single unit job. This accounted for the high unit costs, particularly labor costs. The idea used in injection molding of reducing labor costs by using multiple cavities has been very successful, however. On the other hand, the size of the sheet is limited by the press size and by handling difficulties. Cooling and stiffening occur when unwieldy sheet sizes are used.

After the sheet size and the number of units per mold are determined, the mold itself is designed. Molds can be of the simplest plug and ring type or the more complicated skeleton or rib construction. Straight or draw forming, vacuum molding or blow molding can be used, or a combination of the three can be employed. With difficult shapes, the most important consideration is wall thickness uniformity, and many techniques have been developed to achieve this. Wood is the most common mold material. Laminated phenolic or metal strips are sometimes used to reinforce the wood at the points of greatest friction. When a large number of cavities are used, the mating parts can be made out of phenolic cast in plaster forms.



ACRYLIC BUCKETS, 7 in. deep, for displaying small items are formed six at a time from a single sheet.

TOTE BOXES for the Winchester Repeating Arms Co. are formed from Royalite. Gun stacks fit snugly into the compartments.



Lead cathode fixture being positioned in large vessel head prior to anodic acid treatment.

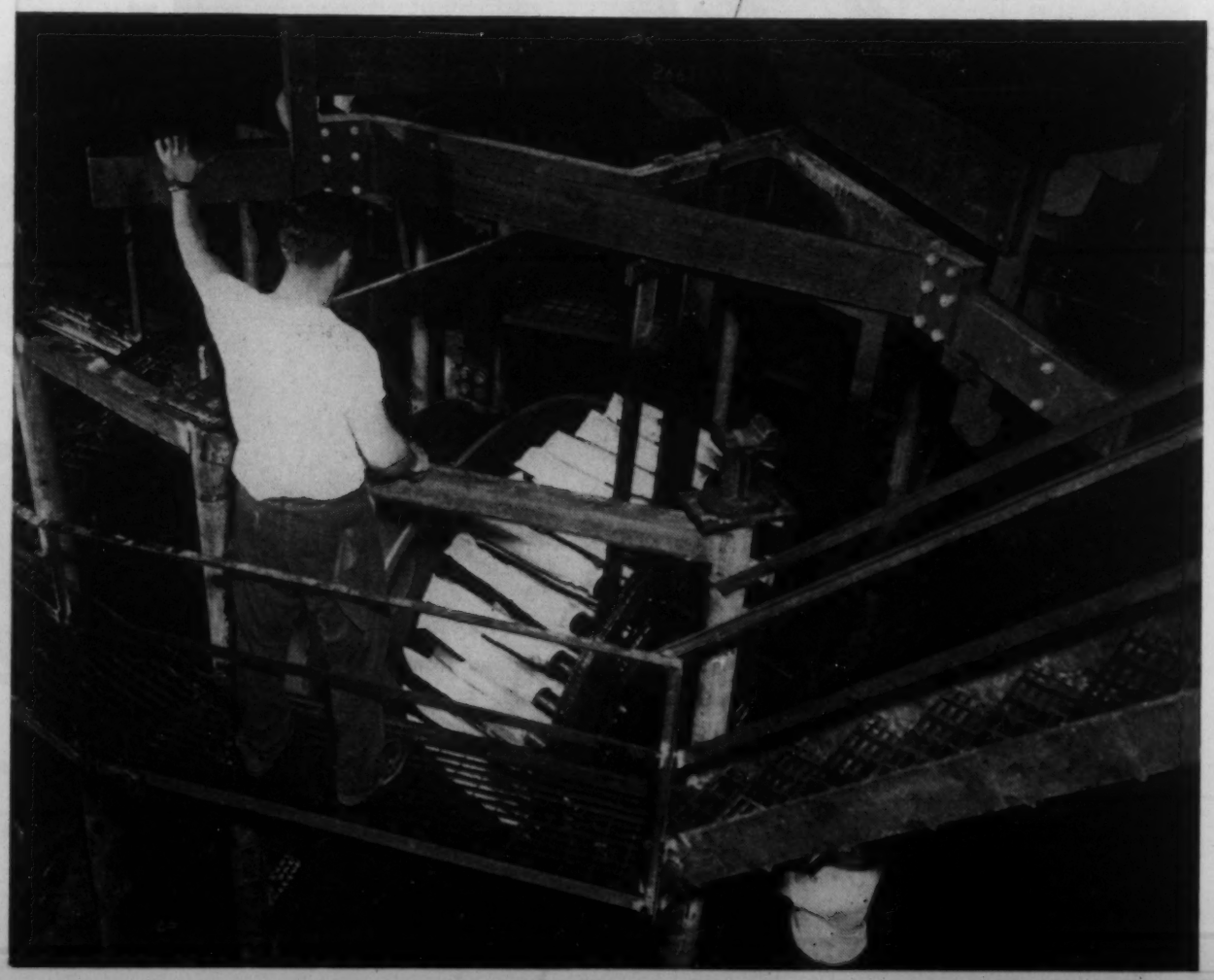
Successful use of electro-plated coatings on large chemical equipment demonstrates that where applicable, they cost less than clad metals and solid metals and alloys.

by F. K. SAVAGE and A. K. GRAHAM,
Graham, Crowley and Associates, Inc.

E. P. STROTHMAN,
Process Equipment Div., A. O. Smith Corp.

Electroplating Large Complex Shapes

Positioning nickel anodes in vessel head prior to plating.



● ELECTROPLATING HAS for some years been used in the chemical equipment field, particularly that branch dealing with the processing and storing of foods. However, plating has been limited to comparatively small and geometrically simple shapes. But recently plating facilities have been available for plating large pieces of several hundred square feet in area and of complex shapes.

For equipment handling corrosive materials, wrought metals and alloys are the most expensive. Clad metals, in which the cladding may comprise 10 to 20% of the thickness, are considerably less expensive than alloys. In applications where electroplated coatings will serve adequately, they are less expensive than clad materials. This is particularly true if a

relatively large number of pieces of equipment of the same size and shape are required so that it is possible to amortize the cost of engineering and installing the plating facilities. Even if adequate facilities are available, the fixtures may still involve considerable additional expense.

The nature of the chemical process and the specifications with respect to contamination of the product determine the selection of the plated metal coating. If tests indicate that such a plated coating will meet the requirements of a specific application, then the aforesaid factors will also influence the required thickness of the plated coating. Other factors influencing the thickness are the geometry of the piece to be plated in its effect on metal distribution and the condition of the basis metal with respect to surface roughness, inclusions and other defects.

Recently, several plants have been engineered to plate items of chemical equipment as large as 700 sq ft in area. These plants have thus far only been employed to plate nickel to a thickness of from 0.005 to 0.010 in., but they are not necessarily limited to nickel plating. Copper, zinc, cadmium, lead, tin and even chromium can be plated on very large items of equipment, with very limited modification, if any, of the existing plating facilities.

The real problem in the production of a plated coating for corrosion resistance in the chemical field is to furnish an adherent, pore-free deposit of satisfactory physical properties in sufficient thickness to give the service life required. While plated coatings in the thickness employed for decorative and protective coatings on automobile parts and other items are considered adequate for the service involved, they do possess a degree of porosity which would prevent their use for many chemical applications. Therefore, in extending the use of plated coatings to this latter field of service, it is necessary to increase the coating thickness in order to reduce the porosity. The coating thickness required for this purpose will be influenced by the adequacy of the various steps involved in the preparation and plating of the basis metal as described in this article.

The basis metal is always hot-rolled steel. It should be of the best quality obtainable, *i.e.*, as free as possible from oxide inclusions, slag inclusions, and such rolling defects as lapped metal, blisters, etc. It should also be carefully pickled before fabrication to remove heavy mill scale.

Design Factors

Several limitations are imposed on the design of equipment which is to be electroplated. All sharp corners should be filleted with as large a radius as possible. This applies to protruding, as well as recessed edges and corners. Horizontal surfaces should be avoided insofar as possible, because during plating top horizontal surfaces will tend to collect sediment which promotes roughness and porosity, and bottom horizontal surfaces tend to trap gas released in plating, which may prevent plating entirely and promote gas pitting. All items should, therefore, be designed to give a slope to what would otherwise be bottom horizontal surfaces. If this is impractical or impossible, the piece must be positioned during plating so that the surface is at a sufficient angle to allow the gas to escape. In extreme cases vent holes can be supplied at the uppermost point of a gas pocket to facilitate the release of the gas. These vent holes can be closed after plating by welding with a welding rod of suitable material.

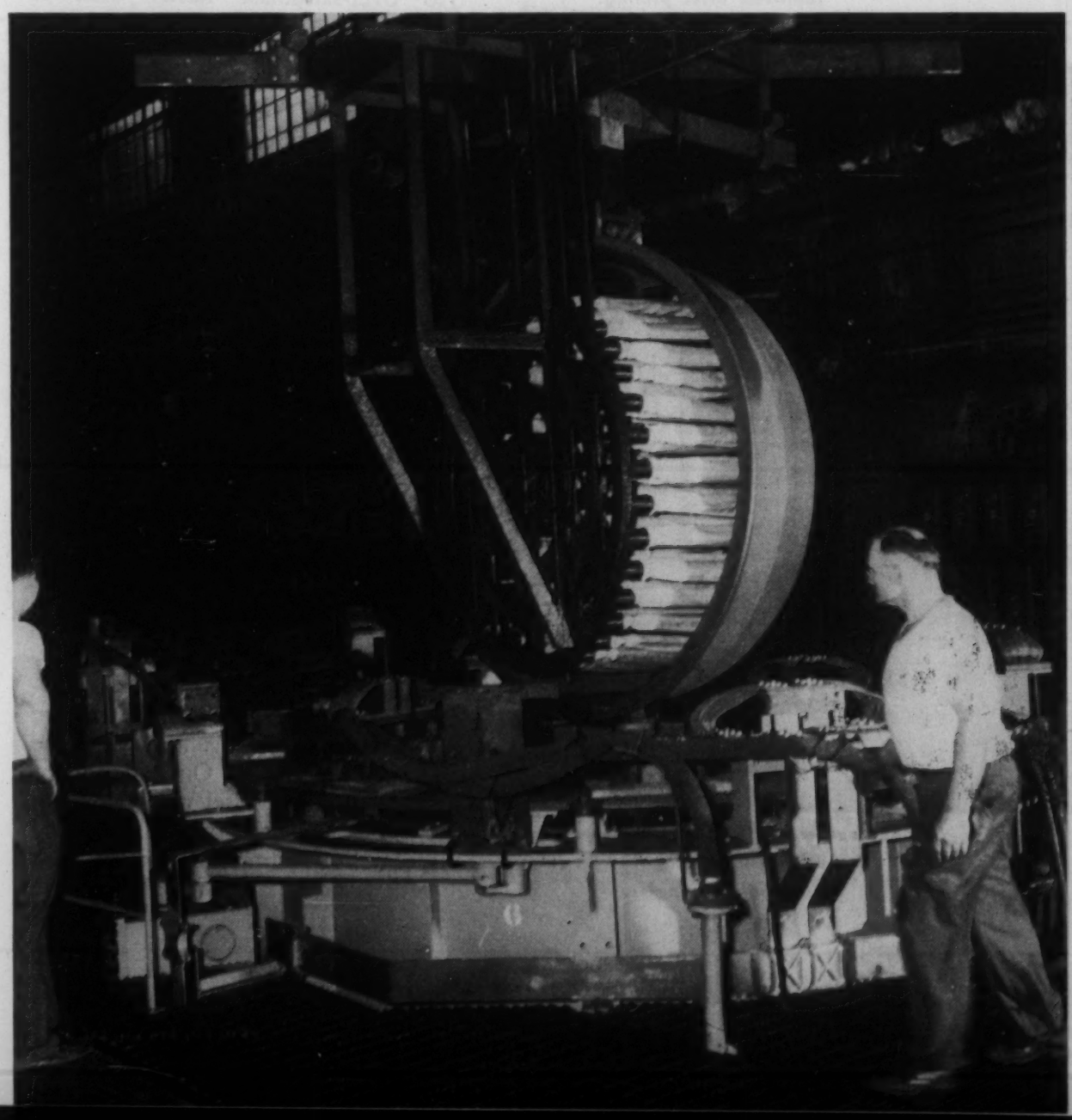
The positioning of the item in treatment tanks for elimination of pockets and carry-over of solution on transfer from one tank to another is as important as for elimination of the gas pockets during plating. Here again, in extreme cases, holes can be drilled at the lowest spot in a pocket to facilitate drainage. These holes are also filled by welding after plating.

It is frequently necessary to modify slightly the design of large items to provide attachments for lifting, handling and turning during fabrication, inspection and preparation for plating, as well as during the cleaning and plating treatments.

Welds

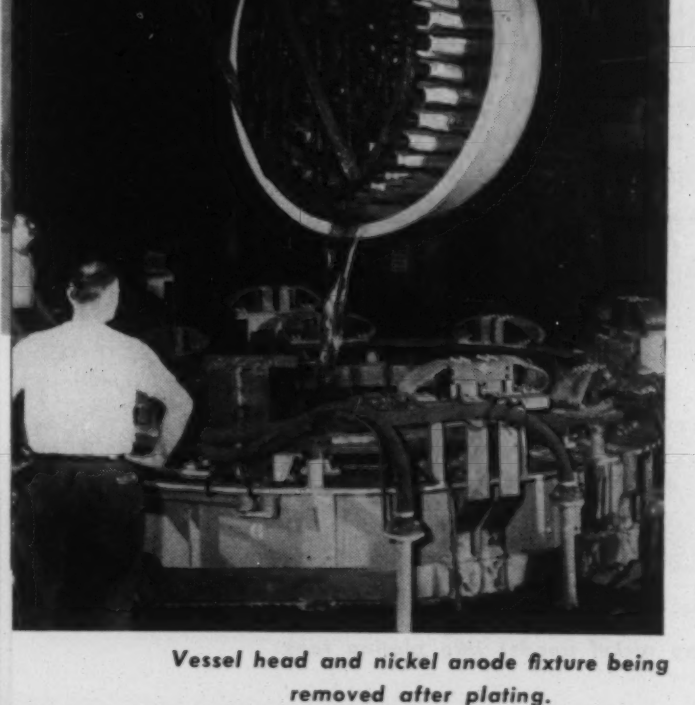
In the welding of assemblies which are to be plated, it is of extreme importance that the weld surfaces are carefully scarfed to aid in obtaining a perfect weld. Of the two types of welds usually employed, the best, where it can be used, is submerged arc welding. Under the proper conditions the weld produced

Lowering vessel head and accompanying nickel anodes into plating tank.

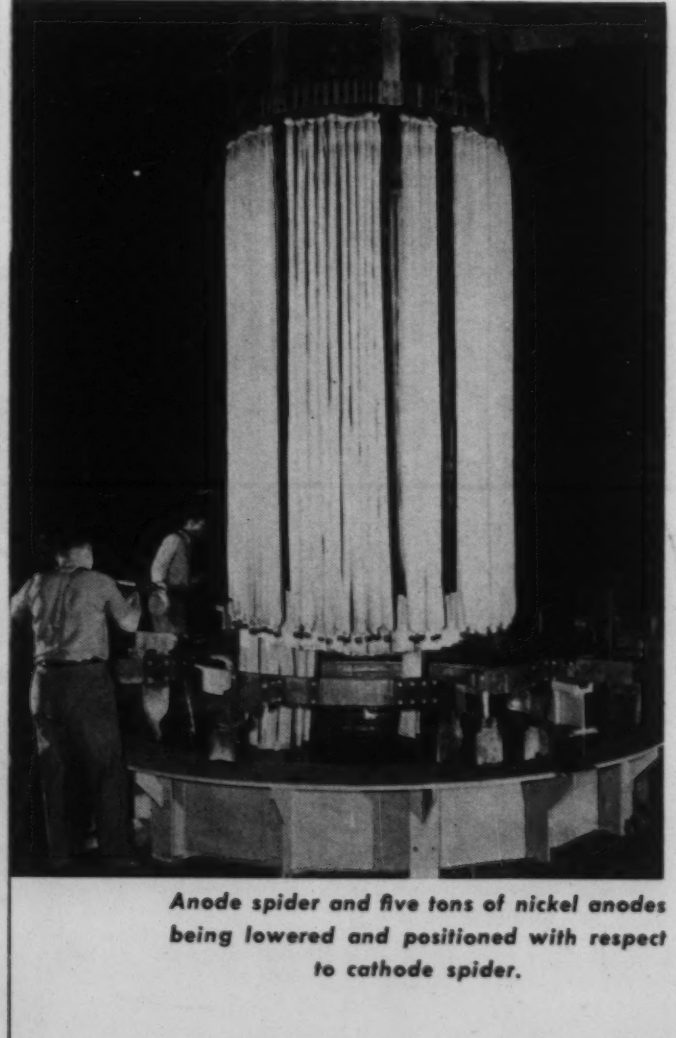


by this method requires a minimum of mechanical surface preparation prior to plating. Hand welds, properly applied by experts, have also been found satisfactory.

A sound, clean weld, reasonably smooth and free from pits, slag, inclusions and undercutting is required for plating. Welds are chipped to surface smoothness, ground reasonably smooth and carefully inspected for porosity. Pits in the welds are ground out. The general rule is that if the bottom of the pit or depression can be seen and the depth of the pit is less than its diameter, the area will probably plate satisfactorily without grinding. Other pits and flaws must be ground. If a pit, flaw or porous area is so deep that it cannot be removed without obviously reducing the wall thickness, the area must be chipped or ground out and refilled by welding. All weld spatter adhering to areas around welds must be removed by grinding or sandblasting.



Vessel head and nickel anode fixture being removed after plating.



Anode spider and five tons of nickel anodes being lowered and positioned with respect to cathode spider.

Sandblasting

The sandblasting of all surfaces is of paramount importance. The purpose is not only to remove defects, such as those mentioned above, but to remove as far as possible oxide and mill scale that is buried in the surface to be plated, even though a subsequent anodic acid treatment is also to be used for this purpose. The surface must be blasted to a perfectly clear uniform appearance, free from visible black inclusions or weld discoloration. The safest procedure is to over-sandblast rather than to slight this operation.

Many grades of abrasive have been used successfully. The size and sharpness of the abrasive, as well as the air pressure, must be regulated so that any tendency to imbed abrasive particles in a metal surface is reduced to an absolute minimum. On the other hand, the abrasive must be sharp enough and must be used with sufficient air pressure to clean the surface adequately in a reasonable time. A medium-sharp 40-mesh sand at 50-lb pressure has been found satisfactory, and other grades of sand and of emery have been used with air pressures up to 100 lb with satisfactory results. It is believed that the properties of the steel may partially influence the results.

Plating Methods

The plating methods for large objects are greatly influenced by the shape, design and overall size of the item to be plated. One method of plating a large vessel with one head in place is to immerse the entire object in the plating solution and use inside removable anodes. In case the vessel is processed with both heads off, removable anodes need not be used, but a center support in the tank with a permanent ring of anodes can be employed. The current can be introduced to these anodes from the bottom of the tank through the pipe used for the support.

Another method of plating a vessel with one head attached is to clean in the conventional manner and then to close all openings and manholes by clamping insulated fixtures to them. The vessel is then rapidly filled with solution and anodes positioned inside. Although this method is successful, mechanical difficulties make it less desirable than the tank method. Sufficient tank capacity for storing the solution must be provided anyway. The difficulty of maintaining the clamping fixtures is considerable, and the time lag in filling and emptying the vessel is expensive. In filling large pieces after cleaning, the time of exposure to aid after cleaning and before the critical surface is covered with solution is too long. One advantage of this method is that only the critical surfaces receive plate and, thereby, less metal is used. In the tank method, *i.e.*, total immersion, the outside surface should also be plated to avoid dissolution of iron and contamination of the solution. Low current density is used both to save metal and to serve for additional electrochemical purification.

Pieces which are hemispherical, such as tank heads, can be plated by the tank-immersion method. They should preferably be placed on edge. The series of accompanying pictures is typical of the plating of large objects with special fixtures. It is also possible to treat items of this type as a vessel and plate in a horizontal position by closing all openings and ports, filling with solution and inserting anodes as described previously.

Large pipe of from 1 to 3 ft in dia and up to 20 ft long is plated successfully. The preferred method is to handle the piece as a vessel with both ends open, immerse the entire piece in a solution, and clean and plate either with a permanent electrode on a bottom stand or by inserting and removing inside electrodes. Another method is to close the bottom end and make the pipe the plating tank by filling with solution and inserting electrodes. This method is subject to the difficulties

and limitations previously discussed.

Pipe can also be plated horizontally while rotating partially or wholly immersed in a solution. This method is subject to some severe mechanical and other drawbacks. If the pipe is not wholly immersed, the upper part of it is exposed to the air as the pipe rotates, which can cause laminated deposits, doubtful adhesion and poor quality, especially if the time in the air and the concentration of impurities in the bath exceed minimum allowable limits. The horizontal plating of pipe presents, in effect, a large surface upon which sediment may settle and cause rough, unsound deposits. Defects due to entrapped gases from plating may also be encountered when the pipes are rotated fully immersed in approximately a horizontal position. The mechanical difficulties of introducing current into a submerged moving surface and of positioning anode fixtures are also profound. One obvious advantage of the horizontal plating method is the elimination of the tremendous head room required for plating pipe up to 20 ft in length in a vertical position. However, floor space must be greatly increased.

Tees, elbows, reducers, curved and tapered sections are being successfully plated with specially engineered fixtures to clean and plate the geometrically involved surfaces with reasonable uniformity.

As in all plating, the cleaning and pickling cycle is of utmost importance in order to insure an adherent and continuous plate. In fact, in plating extremely large surfaces or expensive articles for functional purposes, the importance of proper choice of preplating cycle to avoid rejects is further emphasized. A typical preplating and plating cycle is given in the accompanying box.

The plating bath composition can be varied considerably, depending upon the conditions in the individual plant or on preference. One must make certain that the bath composition and operating conditions are so chosen as to control the stress and the mechanical properties of the deposit. Once these conditions have been established, they must be rigidly maintained within reasonable limits in order that satisfactory quality be obtained.

The most meticulous control of solution composition is required. In addition to the usual scheduled routine analysis of preplating and plating solutions, periodic determinations of iron and copper are necessary. Daily tests by means of the Hull cell and the conventional bent cathode should also be employed to supply an indication of solution performance in respect to pitting and the effect of metallic and organic impurities.

Each plating run should include for bend and adhesion tests a test piece of the same material as the work and prepared in the same way. Periodically, the work is corrosion tested in hot water for several hours to determine its porosity as judged by the number of rust spots per unit area which appear.

Cleaning and Plating Cycle

1. Anodic Alkali Cleaner and Conditions

Cleaner	10 to 12 oz per gal
Temperature	190 to 200 F
Current Density	Min 50 asf
Time	6 min
Work	Anode
Cathodes	Steel or nickel roughly conforming to work surface.

2. Thorough hot and cold water rinse.

3. Anodic Acid Treatment and Conditions

Sulfuric Acid	50% by vol of 66° Be acid
Temperature	85 F max
Current Density	Min 50 asf
Time	6 to 15 min
Work	Anode
Cathode	Lead or nickel

4. Thorough rinsing. Transfer item as rapidly as possible to the nickel plating solution.

5. Nickel Plating Bath and Conditions

Nickel Sulfate	36 oz per gal
Nickel Chloride	12 oz per gal
Boric Acid	5 oz per gal
pH	1.8 to 2.2 (EM)
Temperature	125 F
Current Density	20 to 50 asf
Agitation	Work oscillation or air
Thickness	Depending on specifications, usually from 0.003 to 0.005 in.
Solution Purity	Controlled by analysis for iron and by bent cathode tests, copper less than 5 ppm, iron less than 35 ppm
Filtration	Constant using activated carbon, activated clay and filter aid
Pitting	Controlled by H_2O_2, 1 pint/1000 gal/hr (max)

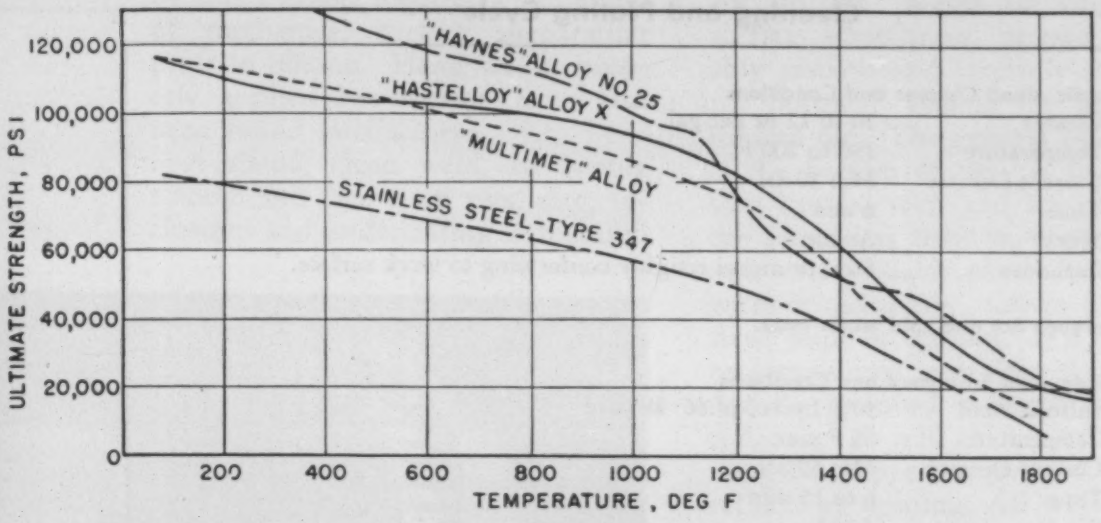
Special Engineering Requirements

In dealing with extremely large items, there are certain mechanical requirements not often found in an ordinary plating installation. Heavy handling equipment, such as traveling cranes from 20- to 50-ton capacity, are usually required. Sufficient head room must be provided, and also provision made for clearance at the top and bottom of the processing tanks and for space for fixtures, agitators and other tank mechanisms.

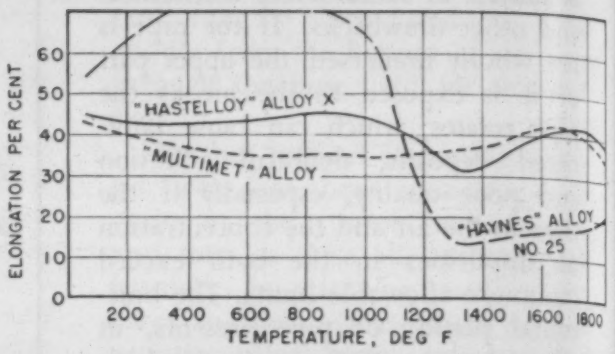
As the size of the item to be plated increases, the fixtures for handling and processing present more complicated engineering problems. Possibly the most important of all fixtures are the current-carrying members and their support. Special attention must be paid to electrical contacts, including contact area, in handling the very large contact current densities involved.

Electrolyte handling and circulation is the same in principle as in any large plating operation. Filtration through filter aids, activated carbon and activated clay at a high flow rate also follows accepted practice.

Precision plating of large and complex shapes for functional uses is a matter of making the utmost use of chemistry and electro-chemistry, plating engineering, and plating know-how. The profound problems introduced by the large weights, the very large surfaces, the intricate shapes, the tremendous current, and the rigid quality specifications require for their solution creative engineering well beyond the conventional.



Elevated temperature tensile strength of several annealed materials in sheet form.

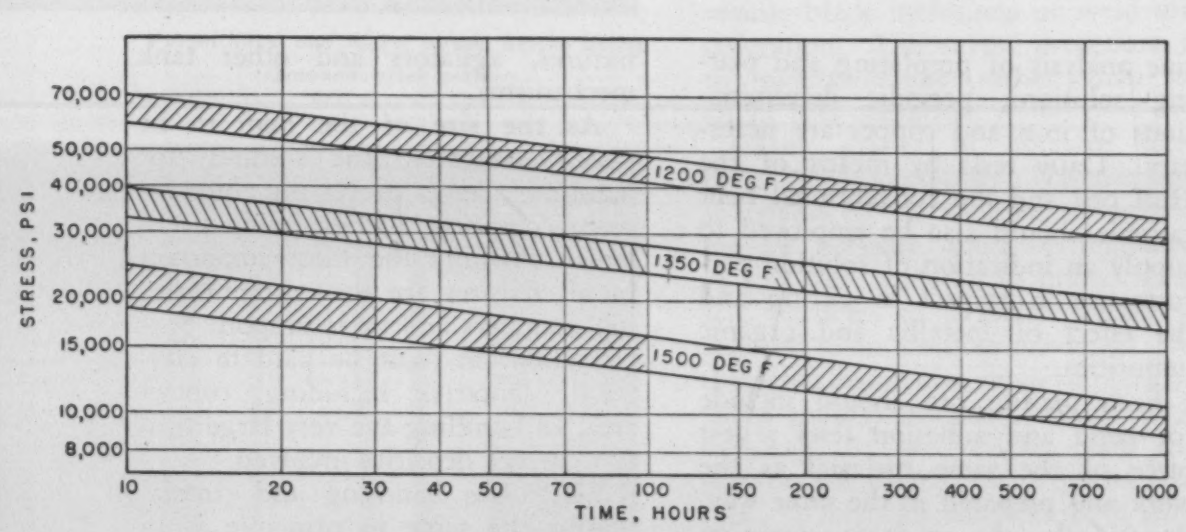


Elevated temperature elongation of some Haynes alloys in sheet form.

New High Temperature Alloy

• • • Contains No Cobalt

• • • Has Good Forming Characteristics



Stress rupture properties of annealed Hastelloy X sheet.

Battery of 36 high temperature furnaces in the Haynes laboratories determine creep and stress rupture properties of high temperature alloys.

—A NEW MATERIALS PREVIEW

● HASTELLOY ALLOY X, a new alloy for high temperature service, has been announced by the Haynes Stellite Co. The new alloy, in which the content of strategic alloys has been reduced, is designed to replace more strategic cobalt and columbium bearing alloys such as Multimet and high nickel, low iron materials in some applications. Hastelloy X contains iron, nickel, chromium and molybdenum, the iron content being sufficiently high to permit the use of ferrochromium in its production, a less critical material than the pure chromium required for many of the high temperature alloys. Tests have shown that the new alloy has excellent forming characteristics, good high temperature properties, and high resistance to oxidation. Hastelloy X is available in the form of sheet, plate, bars, wire and precision investment castings.

Fabricating Properties

Optimum properties in Hastelloy X sheet are obtained by annealing the sheet at 2130 to 2150 F for 10 min, followed by cooling rapidly in air. This is the same annealing schedule employed for Multimet.

After such an anneal, Hastelloy X has excellent forming characteristics. Tests have shown that the new alloy in sheet form is superior to Multimet in formability and equal to Type 347 stainless steel.

Hastelloy X age hardens somewhat after long exposure at elevated temperatures and loses some of its

formability. However, the alloy does not become as hard and brittle as Hastelloy C under these conditions, and it is not considered that age hardening will be a serious problem in most applications.

Elevated Temperature Properties

Hastelloy X was developed for service as a high temperature alloy. Although testing is still in the initial stages, some results are available for comparison with the properties of Multimet, a material on which considerable work has been done.

Short time tensile properties compare favorably with those of Multimet. One the other hand, Multimet has shown superior creep rupture properties. However, Hastelloy X sheet, with the exception of very thin material, has passed the minimum creep rupture requirements established for Multimet. Testing programs are in progress to establish creep properties from 1200 to 1800 F, rupture life at 1650 and 1800 F, thermal shock characteristics and embrittlement effects.

Investigation of the relative oxidation resistance of the new alloy in comparison wtih that of other high temperature materials is in progress. Preliminary tests have indicated that this alloy has high resistance to oxidation.

Composition and Physical Properties of Hastelloy X

Nominal Composition, %
- Chromium, 22
- Nickel, 45
- Molybdenum, 9
- Carbon, 0.15 max
- Iron, remainder

Density, Lb/Cu In., 0.297
Coef. of Exp. per F,
at 79–1800 F: 9.2 x 10^{-6}
Elect. Res., Microhm-Cm 118

Applications

Because of its oxidation resistance, Hastelloy X has replaced Hastelloy C as the roller cover in the Haynes wrought alloy plant rolling and annealing furnaces, a location in which Hastelloy C was oxidized by the hearth cements at the high temperatures required.

Hastelloy X should be suitable for sheet metal components in jet engines, cabin heaters, jet aircraft tail cones and collector ring parts. The new alloy should also prove useful in the process and metallurgical industries. Because of its good casting properties by the investment casting method, Hastelloy X is under investigation for use in aircraft nozzle vanes.

Short Time Tensile Properties of Precision Investment Cast Hastelloy X

Test Temp, F	Ult Str, Psi	Yld Str at 0.2% Offset, Psi	Elong, % in 2 In.
Room	71,000	44,000	22.0
1200	52,000	....	16.0
1350	49,000	....	17.0
1500	47,000	....	19.0
1650	36,000	....	25.0
1800	20,000	....	35.0

Hardness and Bend Test Values of Annealed Hastelloy X Sheet after Aging at Elevated Temperatures

Temp, F	Time, Hr	Hardness,* Rockwell B	Degree of Bend* Before Breaking, Deg
Room	...	85-95	180
1200	502	98	85
1200	553	102	95
1200	81	98	90
1200	102	98	90
1350	5	96	180
1350	14	99	170
1350	70	101	85
1500	572	99	85
1500	172	101	90
1500	299	100	60
1500	124	99	60
1500	129	99	85
1500	30	96	75
1500	33	100	80

** Data obtained from specimen taken from unstressed portion of stress-rupture specimens.*

Comparison of Wrought Hastelloy X and Multimet (N155) Alloys

Alloy	Nominal Composition, %	Temp, F	Short Time Tensile Properties: Tens Str, 1000 Psi	Yld Str, 0.2% Offset, 1000 Psi	Elong, % in 2 In.	Creep Rupture Properties: Stress	Rupture Life, Hr	Elong, %
Hastelloy X	0.15 C max	Room	116	57	44.5	..	....	....
	22 Cr	1200	...	..	38	15	500*	0.285
	9 Mo					45	90	20.0
	45 Ni	1350	68	..	31	..	....	....
	Rem Fe	1500	48	..	37	18	....	35.0
		1650	31	..	41	..	30	....
		1800	20	..	41	..	....	....
Multimet	0.08–0.16 C	Room	116	57	43	..	....	....
	20–22.5 Cr	1200	...	..	35	15	500*	0.175
	2.5–3.5 Mo					45	175	11.0
	18.5–21 Co	1350	55	..	39	..	....	....
	2–3 W	1500	37	..	39	18	80	28.0
	19–21 Ni	1650	27	..	40	..	....	....
	0.10–0.20 N	1800	17	..	37	..	....	....
	0.75–1.25 Co+Ta							
	Rem Fe							

** Tests discontinued.*

Materials at Work

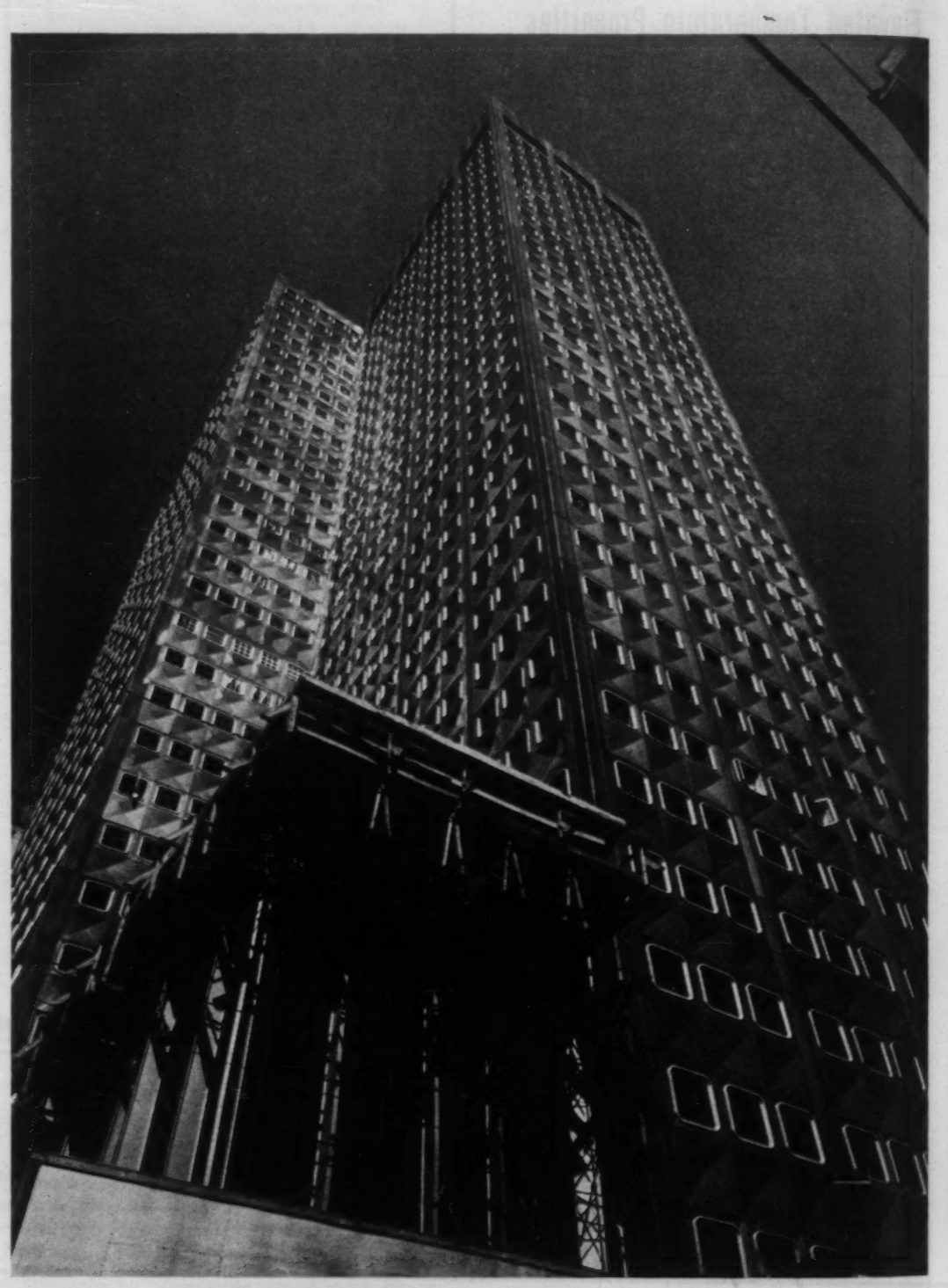
Here is materials engineering in action . . .

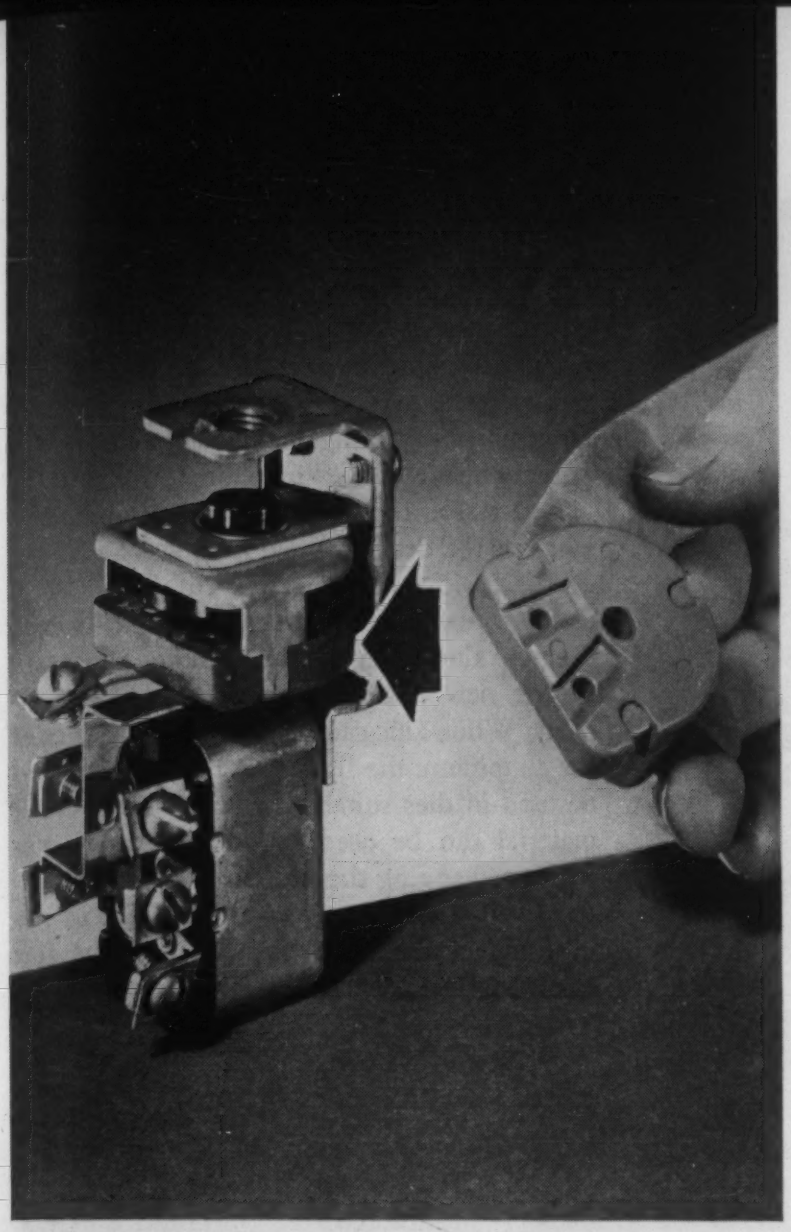
New materials in their intended uses . . .

Older, basic materials in new applications . . .

ALUMINUM IN ALCOA BUILDING

The Aluminum Co. of America's new Pittsburgh office building weighs less for its size than any other skyscraper yet erected. All exterior walls are anodized aluminum. The light metal is also used in the heating and cooling systems. Practically all areas of the building are heated and partially cooled by aluminum-panel, radiant ceiling. Grids of aluminum tubing circulate hot or cold water. The cooling and dehumidification system refrigerating machines operate with condensing water supplied by aluminum cooling towers located on the top level. Due to the good heat transfer of aluminum, water temperatures are only a few degrees higher or lower than the surface temperatures of the panels. The small mass of the aluminum ceiling also makes the panel temperature respond rapidly to thermostat changes.





ALKYD TERMINAL BLOCK

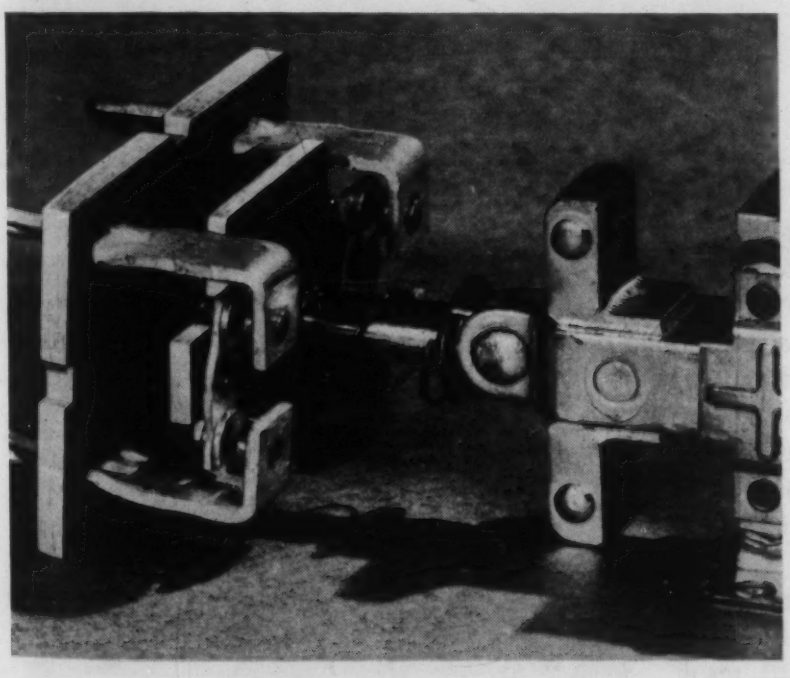
A component of an automotive headlight switch assembly, this terminal block has been molded of Plaskon alkyd plastic chiefly because of the need for extreme dimensional stability in the part.

The manufacturer initially used a ceramic terminal block due to the considerable heat which was generated by the built-in rheostat control for dimming the instrument-panel lights. However, the ceramic blocks presented the problem of dimensional control, and phenolic blocks also proved unsatisfactory.

The switch manufacturer experienced broken terminal blocks due to excessive thickness and loose connections on blocks that were too thin. The rejection losses were sizable, not only of the block itself but of the component part which could not be salvaged once the riveting had been done.

Although the initial cost of the alkyd material was higher than the ceramic, the maker realized substantial savings in the high production rates possible with the alkyd, the reduction in scrap losses, faster and improved assembly methods, and the elimination of complaints from users.

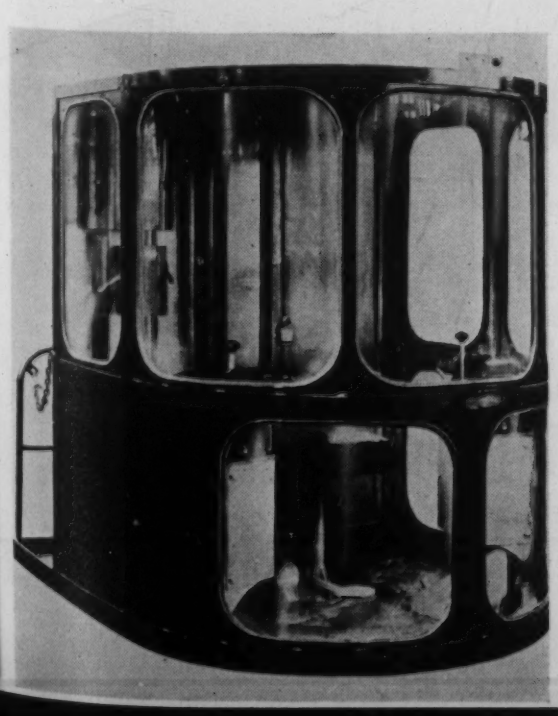
The terminal block is molded for a leading automotive supply manufacturer by Plastics Research Products.



REINFORCED POLYESTER SWITCH PARTS

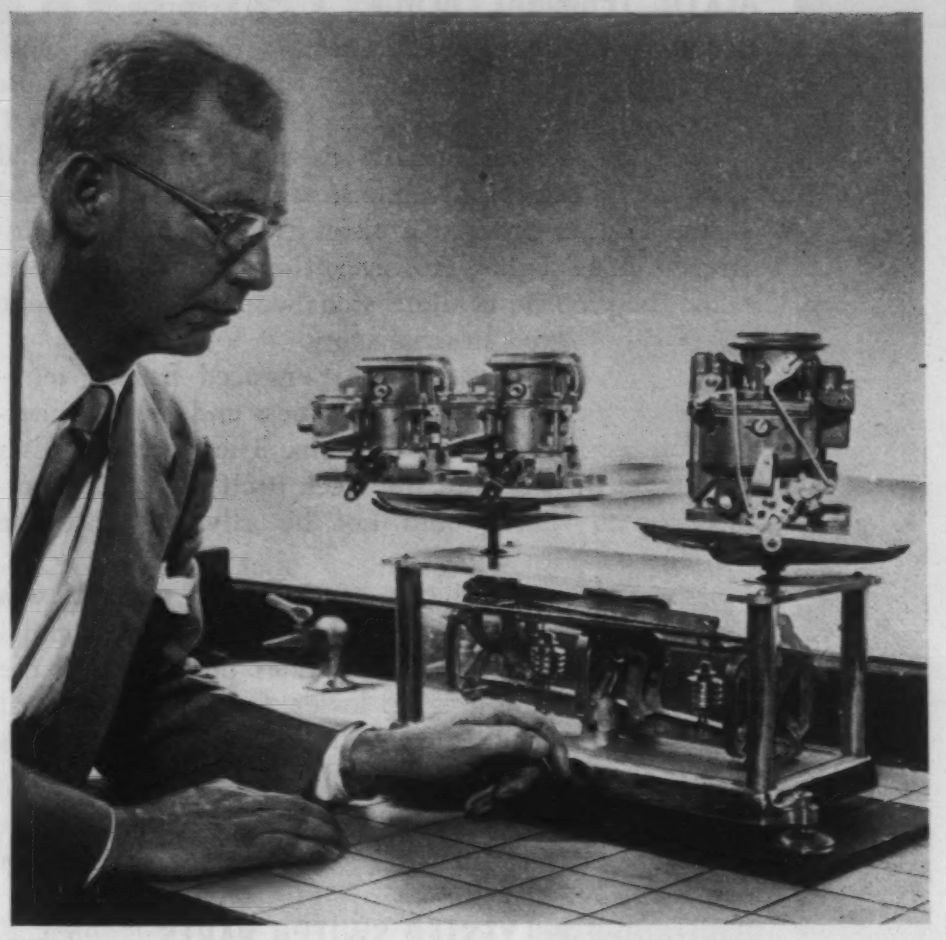
Fiberglass reinforced polyester laminate, made by The Glastic Corp., has been adopted for operating parts of a solenoid switch produced by the Soreng Manufacturing Corp. of Chicago for domestic clothes dryers. The high heat and arc resisting qualities of the material made it possible to use this mechanism, originally restricted to a.c. circuits, in d.c. applications as well. With merely conversion of contact points, this solenoid switch was adapted to handle 50 amps d.c., its original capacity having been 25 amps a.c.

Glastic was selected for this application in place of laminated phenolic type materials because of its dimensional stability, resistance to heat, low water absorption, and excellent insulating properties. Moreover, the new material prevented warping and shrinking at elevated temperatures. The material was first installed for use in the contact head of the switch. After observing the performance in the contact head, the manufacturer made the same substitution in the terminal head, which serves as a mechanical support as well as electrical insulation for the current-carrying elements of the switch.



PLASTIC CRANE CABS

Windows for the cabs of Harnischfeger cranes and excavators are now being glazed for clarity and safety with cast allyl diglycol carbonate sheets, the product of Cast Optics Corp. The new cab windows are as clear as plate glass, their light transmission factor being 92%. Clear vision for the operator is further assured by complete resistance to mechanical and chemical crazing, plus 30 to 40 times the resistance to abrasion of the acrylic plastic windows used previously. Safety of the operator is made sure by the high resistance to impact, chemical action, and the spatter of molten metals. Toughness (resistance to impact on the notch test) is 0.35 ft-lb. Chemical resistance is complete for alkalies and caustics, organic solvents, and all but the oxidizing acids.



ALUMINUM DIE CASTINGS IN CARBURETOR

A new carburetor, smaller, lower in height and weighing less than half as much as the one it replaces, has been designed and developed by Chrysler Corp's. Engineering Div. A two-barrelled type, constructed principally of aluminum die castings, it has entered production for the DeSoto Fire Dome V-8 cars.

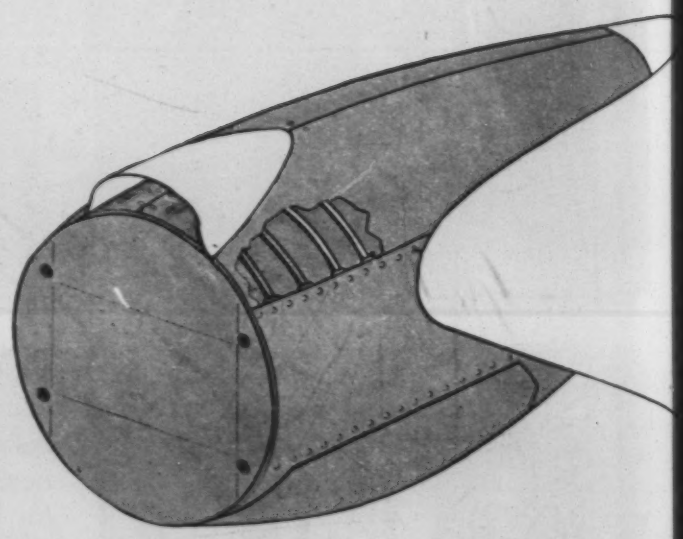
One reason for changing to aluminum from zinc was the desire to save weight. The weight of the basic carburetor was cut from 7.4 lb in the former zinc construction to 3.6 lb with the new aluminum model. Another advantage of the new design is material choice flexibility. While zinc can be used in dies designed for aluminum, the lighter metal cannot always be used in dies suitable for zinc. Thus, either material can be used in the new carburetor without changing the design.

The new carburetors save over 1 in. in vertical space, while maintaining the same fuel and air passage and throttle sizes of the larger type.

TITANIUM IN COMMERCIAL AIRPLANE

Titanium will be utilized in the construction of a commercial airplane for the first time in the new Douglas DC-7 superliner. Approximately 88% of the skin on the DC-7 engine nacelles will consist of titanium sheet. Areas in which titanium will be used include the structural covering of the aft nacelles, some frames, and the landing gear doors. Unalloyed titanium also will be substituted for the stainless steel currently used for firewall webs. Principal advantage of the new metal is that it has the strength of steel yet weighs only 56% as much. Titanium also has heat resistant qualities superior, in some applications, to stainless steel.

In the case of the DC-7 transport, scheduled for production early next year, substitution of titanium for aluminum alloys and stainless steel normally used in nacelle construction will result in a weight saving of about 200 lb per airplane—equal to one passenger and his luggage. On the two outboard nacelles of the DC-7, an area of 11,800 sq in. of 0.025-gage titanium will weigh only 64 lb. This compares with the 68-lb weight of the 8000 sq in. of stainless steel in comparable nacelles of the DC-6B. Inboard nacelles of the new airliner will have 11,300 sq in. of titanium, weighing 64 lbs. On the DC-6B, the 7600 sq in. of stainless steel weigh approximately the same. Landing gear doors of the DC-7, larger than on the earlier model Douglas transport, will utilize 2000 sq in. of titanium, compared with the 1700 sq in. of steel on the DC-6B. A gage-for-gage substitution of titanium for steel in the 11,500 sq in. of firewall will result in a weight saving of around 64 lb.

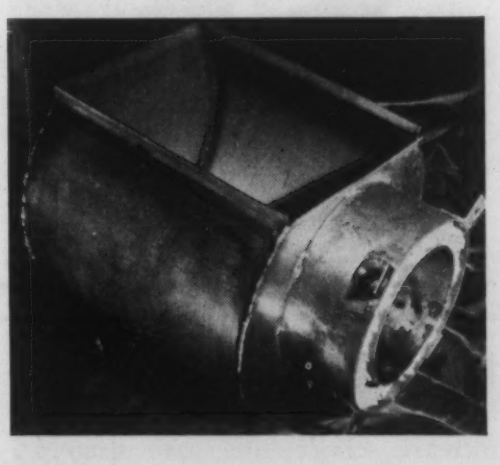


Materials Applications of Tomorrow

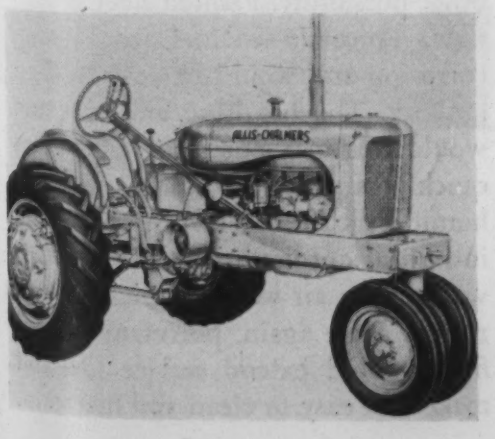
Porcelain Enamels

A committee of the Porcelain Enamel Institute has compiled data on new uses for conventional porcelain enamel coatings. This information was gathered to help members of the Institute broaden their business. The committee report was in the form of a list. Each product was described and the service conditions were given. The advantages of porcelain enamel in each case and the prospective market are also described. Included in the listing are many applications for which porcelain enamels have never been tried. In other cases, their use has been on a limited scale.

HEATING EQUIPMENT A number of the new applications are in furnaces, radiators, space heaters and convection heaters. . . . Combustion chambers for gas and oil furnaces, now made of cast iron, heavy steel plate or stainless steel, look like efficient applications for porcelain enamel. These chambers are subject to severe temperature changes, to heat scaling and to corrosive gases. Enamel coatings would protect against heat and corrosion, raising efficiency by allowing thinner chamber walls to be used. . . . Humidifier pans installed in warm air furnaces are now made of cast iron, copper, galvanized steel or stainless steel. They are subject to severe corrosion from mineral deposits and the chemical action of boiling water. Coated pans would resist corrosion and would be easy to clean. Lime deposits would not adhere as tenaciously to the surface. . . . Porcelain enamel would also add to the appearance and the service life of home furnace exteriors and space heater casings. Mechanical durability and resistance to heat and corrosion would be valuable here. Home convection heating elements are now covered with painted steel baseboards. The paint discolors with the heat and the metal scratches and gets dirty quickly. Porcelain enamel would solve these problems. Porcelain enameled radiators are also suggested. These would



be lighter, resistant to corrosion by water or steam on the inside, more efficient in heat transfer, and would eliminate the necessity of repainting discolored radiators.

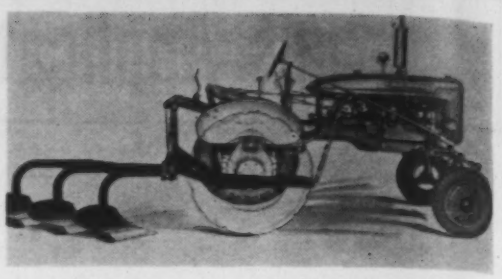


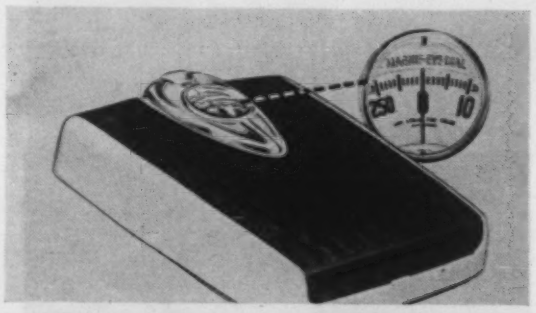
AUTOMOTIVE PARTS In the automotive industry, tractor and track exhaust manifolds and commercial vehicle mufflers are prospective applications. These parts are subject to intense heat, corrosion and vibration. Manifolds are now made of cast iron. Sheet metal manifolds, with porcelain enamel coatings, would be fully resistant to operating conditions. Mufflers are now made of galvanized or aluminized steel, to operate at 800 F with gasoline engines and up to 1450 with diesel power plants. Porcelain enamel would give the necessary permanence and would prolong the life of the muffler. The high heat emissivity of the coating would also retain the strength of the base metal at operating temperatures. (Allis-Chalmers Co.)

(Please turn to page 104)

Materials at Work

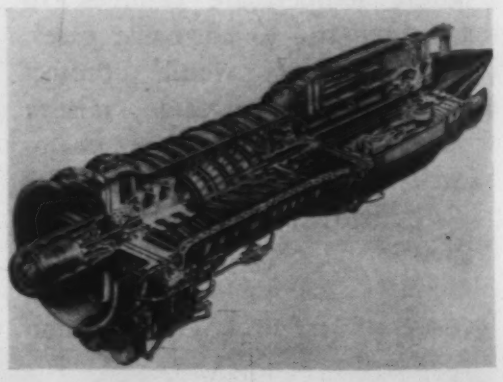
FARM EQUIPMENT The severe service conditions farm equipment is exposed to makes porcelain enamel an economic finish for many parts. . . . Plow moldboards, now made of bare steel, would be more resistant to corrosion and abrasion and would not require polishing if coated with porcelain enamel. The moldboard is now made of a layer of low carbon steel placed between two abrasion resistant layers of high carbon steel. A moldboard pressed out of one piece of enameling plate would be easier to fabricate. For this reason, a porcelain enameled moldboard would be much cheaper than the present unit. . . . Pans and containers used for manure, fertilizer and poultry droppings could also be coated successfully. Many of these containers are now made of wood or of galvanized sheet. The corrosion problem is severe and abrasion in normal use often damages zinc coatings. Porcelain enamel would largely solve these problems and would also be easy to clean. . . . Manure spreader bottoms, lawn fertilizer carts and grain drill fertilizer hoppers are possible applications. Porcelain enamel would also give good service in stock watering bowls, feed trays, feeder pans and troughs. Sales appeal, easy cleaning, corrosion resistance and, to some extent, abrasion resistance would be valuable in these products. (International Harvester Co.)

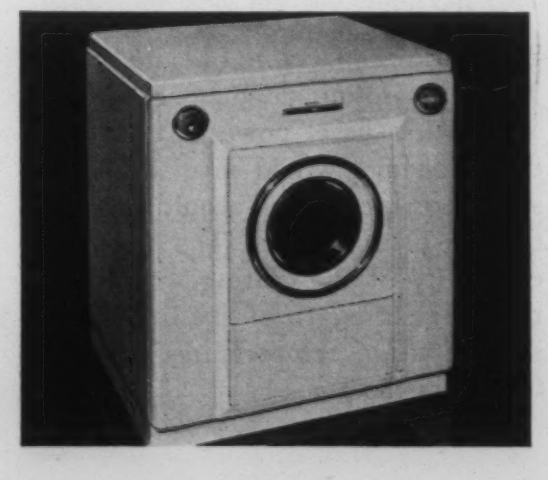




BATHROOM EQUIPMENT Bathroom and washroom equipment used in homes, hospitals, clinics and medical offices is subject to dampness, scuffing and attack by medicines, cosmetics and disinfectants containing corrosive ingredients. Most of these items are now made of steel or aluminum and are paint enameled. Bath scales, paper towel dispensers, hot air hand dryers and medicine cabinets are typical products. Porcelain enamel would increase the price, in each case, but the ease of cleaning, elimination of pit rusting, resistance to scuffing, permanent color and increased sanitation would be big advantages. (Detecto Scales, Inc.)

MILITARY APPLICATIONS Porcelain enamel on military parts can increase service life, save strategic materials and improve performance. Jet engine parts are subject to high temperatures. Porcelain enamels can be used effectively in many jets parts. . . . Back cases for search and flood lights are subject to atmospheric corrosion. Porcelain enamel of low reflectivity would give permanent weather protection, reduce maintenance, and probably assist in giving off the tremendous heat generated inside by the arc lights. . . . Steel ship bulkheads would be protected from fire, salt water corrosion and frequent cleaning. Confinement of fire is the outstanding benefit of porcelain enamel. (Westinghouse Electric Corp.)

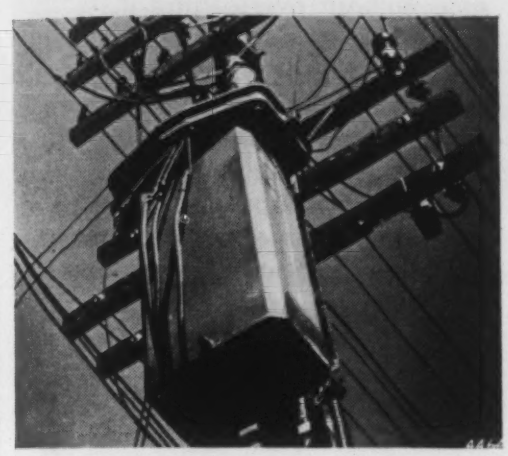




HOME APPLIANCES Applicances resist corrosion better with porcelain enameled surfaces than with painted steel or iron. . . . Tops of home laundry dryers can be made scratch free and nonstaining. Bluing, bleaches and the heat from the dryer will not affect the coating. The dryer drums can be protected in the same way to resist wear and discoloration and remain easy to clean. These drums are now made of bare steel or galvanized steel. . . . The tops and exteriors of home freezers are another possibility. Painted steel is used now. Porcelain enamel would stop corrosion and would be easy to keep sanitary. The handling and abrasion would not mar porcelain enamel as quickly as painted surfaces. . . . Dehumidifiers for basements, vaults and industrial applications are subject to water-laden air which accelerates corrosion. Here again, porcelain enamel finish would extend service life and make unit easy to clean and maintain.

ELECTRICAL EQUIPMENT COVERS

Switch escutcheon plates and switch and junction boxes are subject to wear and are often exposed to high moisture content atmospheres. Porcelain enamel would provide electrical protection on these products and would prevent rust. Enameled switch boxes would be especially desirable in breweries, meat packing plants, chemical plants, textile and paper mills. (Westinghouse Electric Corp.)

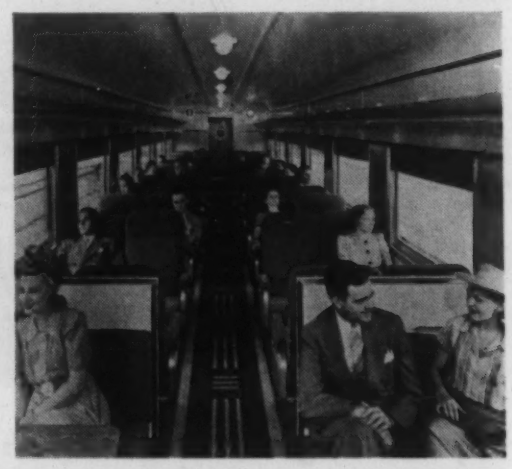


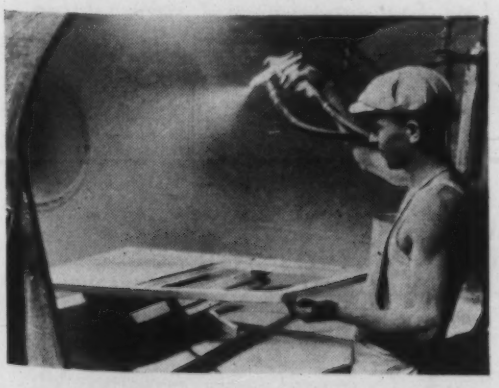
OUTDOOR PRODUCTS

Many metal articles that are exposed to atmospheric corrosion, sun and rain look like good bets for porcelain enamel. Organic finishes fade, crack and chalk off. The permanency of porcelain finishes would be valuable. . . . Outdoor metal furniture, mail boxes, steel trash cans, identification signs and metal window display boxes for theaters and stores are typical outdoor applications. Porcelain enamel would increase the initial product cost in these competitive fields, of course, but the longer service life might well outweigh the initially higher price. . . . In industrial fields, air conditioing cooling towers, small smoke stacks and transformer tanks may be good applications. One big advantage would be the fact that no repainting would be required.

RAILROAD CARS

Porcelain enamel could be used on interior and exterior parts of railroad passenger cars. The colored window spandrels and the car identification signs are outside applications. These pieces could be cleaned easily and would resist grit abrasion. The porcelain enamel coating would also maintain the desired colors. On the inside, the side panels of coaches, diners and lounge cars, the aisle seat bases and washroom panels could be porcelain enameled. All these surfaces are now painted. They are subject to scuffing and strong disinfectants, and the paint soon wears away. Color retension and wear resistance of porcelain enamel would definitely cut maintenance.

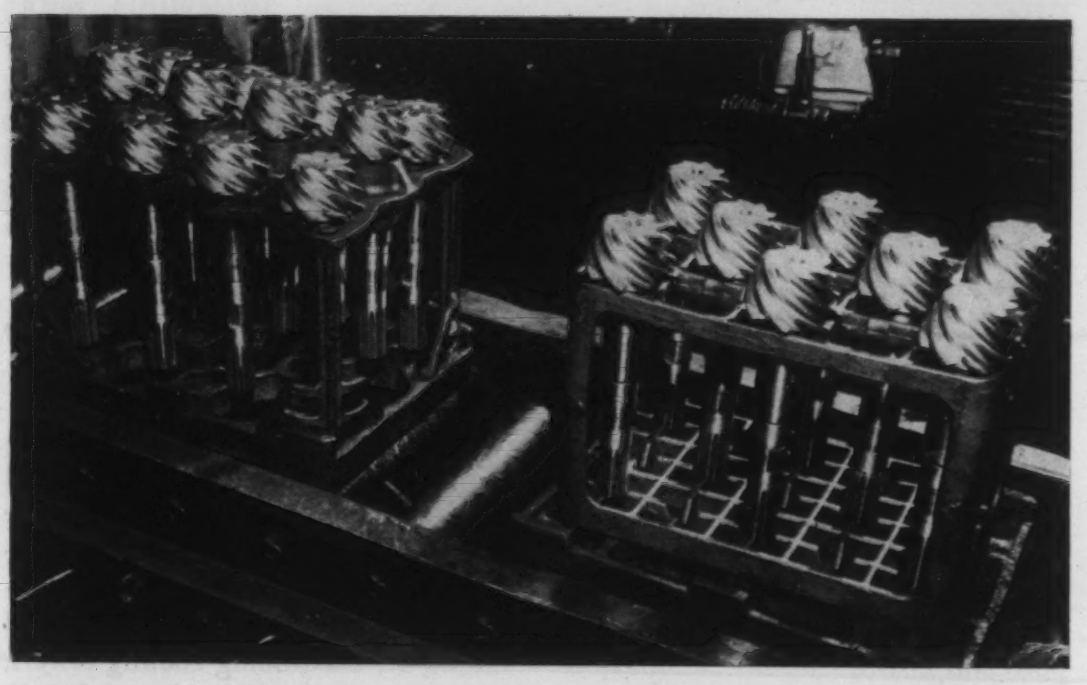




PROCESSING EQUIPMENT

Porcelain enamel could be used on industrial spray booths, smoke house wall panels, ventilating hoods and industrial dryer liners. The smooth surface would be advantageous in not picking up dirt and remaining easy to clean. The enameled metal would also resist heat, moisture and cleaning compounds. . . . Food processing equipment and machinery parts are other possible applications. Commercial dishwasher housings; dishwasher water pumps; meat grinder housing, hoppers, trays and platforms; turbo pump impellers; as well as syrup tanks and canisters for use in vending machines all would be a great deal more sanitary with porcelain enamel coatings.

NOTE: The pictures used in this presentation are for illustration only. It should not be assumed that the companies credited are using or studying the use of porcelain enamel in the equipment shown. The opinions expressed are those of the Porcelain Enamel Institute, not necessarily those of the equipment manufacturers.



Redesigned tray, at left, used in heat treating rear axle drive pinions is lighter in weight and carries 12 pinions compared to only eight carried by the old tray on the right.

One Way to Increase Heat Treating Furnace Efficiency

By redesign of fixtures, this heat treating department reduced dead weight and increased the effective capacity of their furnace without overloading it.

by FRANK PANLENER,

Heat Treat Superintendent, Nash Motors Div., Nash-Kelvinator Corp.

● EVERY HEAT TREATING department is concerned with operating its equipment at maximum efficiency. Since maximum efficiency in heat treat furnaces is closely associated with maximum rated capacity, it is worthwhile to study how closely the work load going through the furnace compares to this rated capacity. Equipment operated at a level below its rated capacity is subject to the higher fixed charges that go with its capacity rating. Also, the heat input to the furnace is usually so determined that its maximum efficiency will occur near the capacity rating.

The rated capacity of a heat treat furnace is the number of pounds of metal that can be heated to some definite temperature per hour under the existing operating conditions. This includes both the weight of the pieces being treated and the weight of fixtures necessary to contain or support them during the heating cycle. The first might be called *live weight* and the second *dead weight*, or *tare weight*. It is this tare weight that affords an opportunity to increase the effective capacity of a furnace without overloading it.

The use of fixtures to support the work is especially necessary in the case of most carburizing furnaces, in order to prevent blanketing of some areas and resultant soft spots. While furnaces with moving hearths or retorts are available to solve this problem, the solution does not apply to all kinds of work. In carburizing gears, for example, there is no completely satisfactory substitute for proper support of workpieces as they stand or move through the carburizing medium.

Such fixtures are usually made of rather costly high-nickel alloys, and because of their high cost they are made to give long service. This may involve use of considerable metal. Cast fixtures are sometimes made with heavier cross-sectional area than would be necessary for strength purposes in order to make the piece more easily castable. While the heavier fixture will be more durable, it may be causing a considerable loss in net furnace capacity. This use of heavy fixtures is by no means confined to those produced by casting, nor to those made of expensive alloys. Fixtures heavier than necessary may sometimes be used simply because they are available. While this may be justified in a job shop, or for experimental runs, it can be costly economy in high-production work.

The full effect of tare weight in heat treating furnaces is not always realized. The more important considerations in terms of furnace economy are:

1. Reduction of live weight in a given furnace.
2. Loss of furnace heat.
3. Increased labor requirements.
4. High fixture costs.

There are other corollary items that can be added to the list, such as the possibility of using a furnace of smaller capacity by reducing tare weight, saving floor space through use of a small furnace or through lowered amount of total weight to be

handled, lowered inventory of fixtures, and so on. The most important consideration, however, is the possibility of increasing the weight of workpieces that can be treated by reducing the tare weight per load.

As an example of what can be done, the result of change of equipment in a deep case gas carburizing furnace at Nash Motors is of interest. This furnace is used to carburize rear axle drive gears and pinions and differential side gears, and is a gas-fired Surface Combustion radiant tube furnace of conventional design. The pieces are carried in alloy trays, with alloy fixtures for additional support when stacking. Rated capacity of the furnace is 1364 lb per hr. The feed is of the pusher type, making 6¼ pushes per hr. The hearth provides space for four lanes of trays.

A recent study of the furnace capacity and actual work loads, undertaken to determine where production might be increased without making any important capital investment, led to some interesting conclusions. As the furnace was operating at capacity, the best chance to increase production seemed to be through the reduction of tare weight, and conversion of this dead weight into live load. Design of the fixtures was studied to determine if any substantial weight saving was possible.

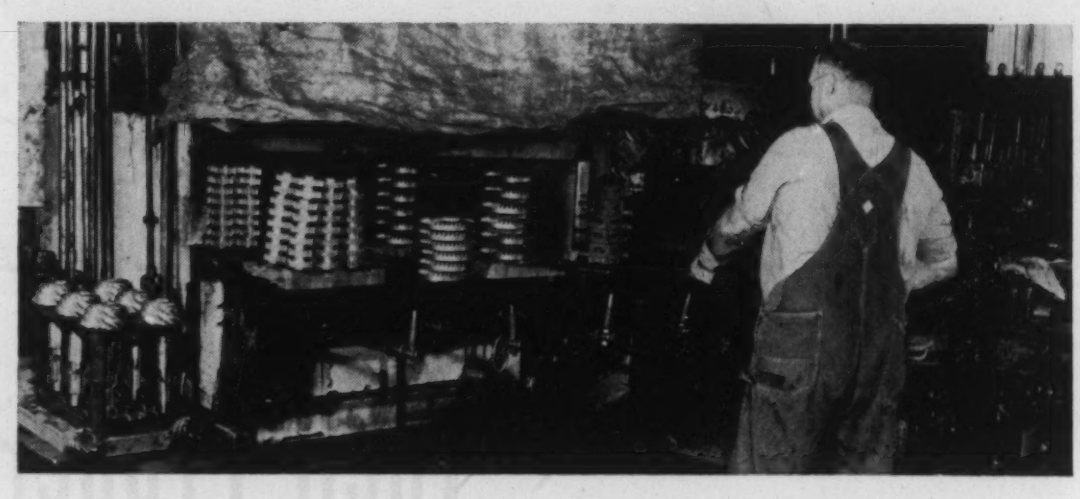
Fixtures used included the trays themselves, which weighed about 19 lb each. Ring gears were supported on spacers, which were cylindrical pieces of alloy sheet. Other gears and pinions were supported on pins that fitted into sockets. Drive pinions were held in special solid fixtures, each holding eight pinions. Weight of most of the fixtures was not excessive, and only the box fixtures used for the drive pinions seemed to promise savings through redesign.

It appeared, however, that furnace live load could be increased by reducing the lanes in use from four to three by loading each tray more heavily. This reduction in the number of lanes used would make the tare weight of one tray available for increased live load six times an hr. Heavier loading of the trays was necessary, as shown:

With four lanes in use,
1364 lb per hr furnace capacity
341 lb per lane per hr
$\frac{341}{6}$ pushes per hr = 57 lb gross wt per tray.

With three lanes in use,
1364 lb per hr furnace capacity
455 lb per lane per hr
$\frac{455}{6}$ pushes per hr = 76 lb gross wt per tray.

The total saving in tare weight through the use of only three lanes instead of four is 19 lb × 6 pushes per hr, or about 114 lb per hr.



Gears being placed at loading end of deep case gas carburizing furnace.

Redesign of the box fixture used for the drive pinions produced a support in which pins hold grids that separate the individual pieces. The new fixture is about 15 lb lighter than the box fixture it replaces, and holds 12 pinions per tray instead of eight, as did the box fixtures. In the case of the differential side gears and pinions, which had been supported on pins, no weight saving was possible in the fixture, but the number of pieces strung onto each pin was increased.

In order to study the correlation of this heat treating operation with overall production scheduling, the accompanying table was set up. The table indicates that whereas the upper production requirements would have been impossible to meet with the trays in four lanes, the use of only three lanes, heavier loading of the trays, and higher live load enables the furnace to meet any of the proposed production schedules.

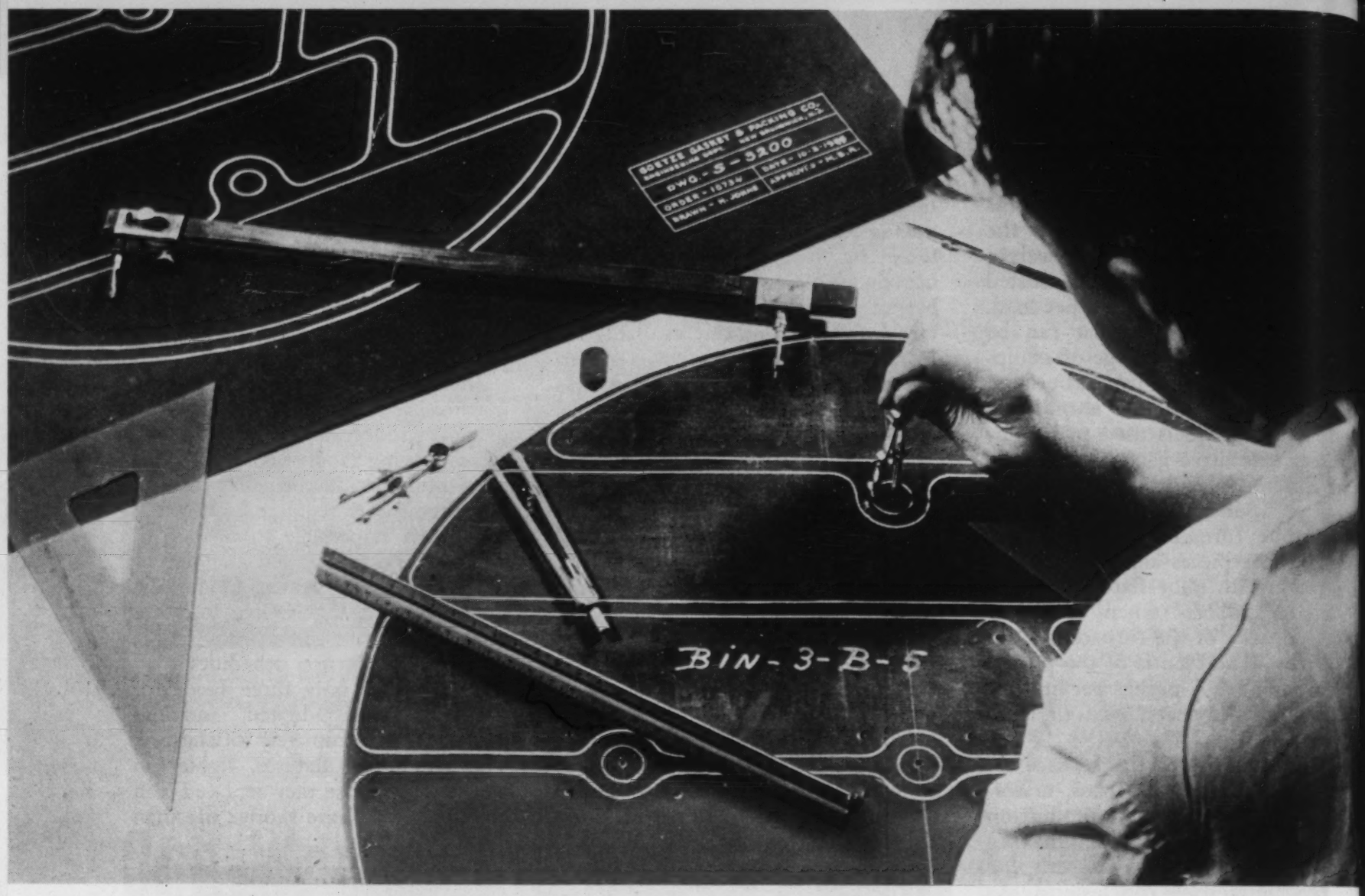
The use of only three lanes for trays has been adopted, and has proved to be completely satisfactory. The redesigned fixtures, lighter in weight than those they replaced, can be expected to have shorter life than the heavier pieces, but they have not yet been in use long enough to estimate how much shorter the service life will be. It is certain, though, that any likely increase in fixture cost will be minor compared to the savings effected. These include lower fixture first costs, and lower fixture inventory.

Leaving one lane open gives the furnace a degree of flexibility in operation. A failure in one of the operating lanes, such as a stoppage in that lane, can be by-passed by switching to the unused lane.

While the actual increase in live weight through the furnace by elimination of the fourth lane is slightly less than 10%, the redesign of the fixtures increases this advantage. The total increase in weight of parts through the furnace is about a ton and a half per day.

Correlation of Heat Treating with Overall Production

Scheduled Production	Four Lanes		Three Lanes	
	No. of Trays of Parts Required	Operating Hr per Day Required	No. of Trays of Parts Required	Operating Hr per Day Required
1100 Cars	739.3	29.6	427	22.8
1000 Cars	672	26.9	388.3	20.7
900 Cars	605	24.2	349.5	18.6
800 Cars	537.8	21.5	310.6	16.5
700 Cars	470.5	18.8	272	14.5
600 Cars	403.3	16	233	12.5



One of the most important considerations in designing a gasketed joint is the choice of a gasket material. (Johns-Manville)

Gasket Materials—

Their Properties and Uses

Available to meet the many different service conditions under which gasketed joints must function are a wide assortment of synthetic and natural materials.

by SIDNEY G. KELLEY, JR.

● THE GASKET IS one of the most important components in a modern machine, and its proper functioning depends to a great extent on the material of which it is made. However, because it is easy to replace and is frequently made of comparatively inexpensive material, often too little attention is given to choosing the right material.

A gasket is a resilient, somewhat yielding part that is placed between two rigid, unyielding parts to make a light, leakproof seal. Gaskets are used in static applications where no motion of the rigid components is supposed to occur. They differ from packings, which are used to seal moving parts.

The first requirement of a gasket material is resiliency. The gasket must be compressed by the flanges, and must react on the flanges to maintain an effective sealing pressure. The gasket must be resilient enough to exert this pressure without taking too much of a permanent set. The gasket must also be impermeable to the fluid at the pressures encountered.

The operating temperatures and pressures, the chemical properties of the fluids contained, the dimensional accuracies required, and the material of which the flanges are made dictate the choice of a specific material

in particular cases. Dimensional accuracy is largely commensurate with the hardness of the gasketing. Where it is necessary that specific dimensions be maintained between the flanges of a joint, a relatively hard material should be selected that will behave as close to predetermined characteristics as possible.

The flanges must be considered primarily from the standpoint of corrosion and whether or not the gasket will be a contributing factor to their destruction. This is true in the case of metallic gaskets, where the contact of unlike metals is likely to set up galvanic corrosion. Corrosion, or flange staining, can also be caused by the wrong choice of a nonmetallic material.

The committee appointed to set up specifications for automotive gaskets for the ASTM and the SAE has adopted a simple classification system for gasket materials. With certain additions, this system is used in this article. The materials are divided into categories according to their composition as follows: (1) rubber, (2) cork, (3) plant fibers, (4) asbestos fibers, (5) metals, (6) plastics, (7) leather, and (8) felt. In general industrial applications, the most widely used materials are plant fibers, asbestos, rubber and metals.

Rubber

Rubber is a noncompressible material. In a gasket it maintains a constant volume regardless of the bolt pressure. As the joint is tightened, the rubber spreads out and the area of the gasket increases. Friction between the rubber and the flange surfaces opposes this flow, and the greater the friction, the greater the load needed to depress the gasket a given amount.

Operating temperatures are important with rubber gaskets. Most of these materials cannot be used above 375 F, although a few formulations can withstand considerably greater heat. Intermittent temperatures above 375 F can be taken for short periods by some rubber gaskets. Low temperatures also limit the use of rubbers. They become brittle or lose resiliency. Most compounds cannot be used as gaskets below about —40 F.

Certain hydrocarbons, and especially petroleum oils, are likely to be detrimental to rubber gasketing. Oils reduce the friction of rubber to the extent that, where a load of 2800 lb was required in one test to cause a deflection of 25% for Neoprene between silicon carbide flanges, only 250 lb was required for the same deflection when the material was placed between cold rolled steel flanges coated with petrolatum. Rubbers also tend to swell in almost exact inverse proportion to the analine points of the oils in which they are immersed.

Natural rubber is characterized by great resilience, imperviousness to water, temperature resistance up to 325 F (special formulations up to 375 F) and high resistance to acids and alkalies when used with special filler materials. Swelling due to oils can be decreased by compounding with oil resistant synthetics but cannot be eliminated. Ozone is a cause of severe cracking and must be guarded against by the incorporation of 1 or 2% of wax in the formulation. Natural rubber can be fabricated by molding, extruding, calendering into sheet, or coating onto other materials, including fabric, metal foil and paper.

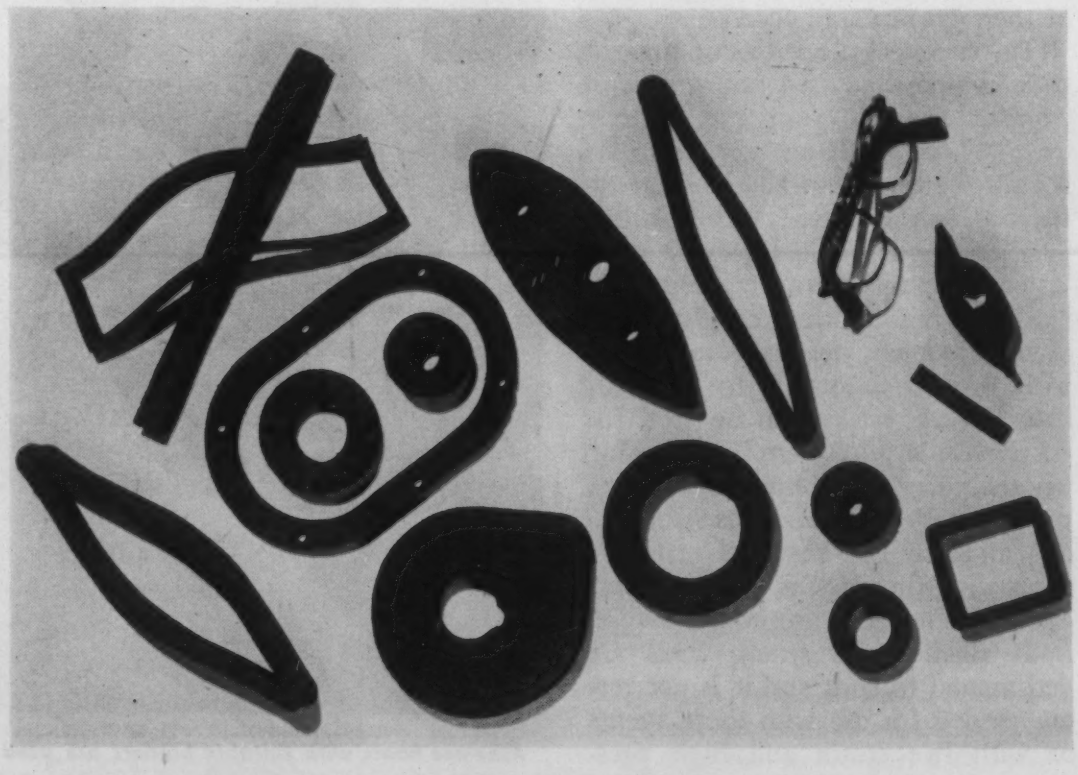
Butadiene-Styrene (GR-S or Buna-S) generally has the same properties as natural rubber. Physically, it is slightly weaker but more resistant to heat and has better resistance to most oils. It is fabricated in about the same manner as natural rubber. Butadiene-styrene is the most commonly used rubber gasketing material.

Butadiene-Acrylonitrile (GR-A or Buna-N) has fair physical and heat resistant properties, but has poorer resistance to low temperatures than natural rubbers. Excellent resistance is shown to the swelling action of ordinary petroleum oils. It is fabricated in the same manner as natural rubber but, being somewhat intractable, does not lend itself to all operations.

Chlorobutadiene (Chloroprene or GR-M), commonly called Neoprene, is easier to handle than acrylo-rubbers and is somewhat stronger. It will give continuous service at 300 F. While other rubbers excel its resistance to oils, chemicals, sunlight, weather or ozone, none match its resistance to all of these. It is fabricated in the same way as natural rubber but does not require sulfur in its vulcanization.

Polysulfide (Thio types), marketed as Thiokol, shows physical properties generally inferior to other synthetics. It is less heat resistant, more thermoplastic, and characterized by strong onion-like odors. It is, however, superior to other synthetics in resisting the swelling effects of benzol, chlorinated solvents. Fabrication is similar to the methods used for natural rubber, but vulcanizing can be done with metal oxides rather than sulfur.

Isobutylene (Butyl Rubber) has poor physical and chemical properties except for a high resistance to strong acids such as nitric acid. The principal use is for resisting acids. Fabrication is done in the same way as for natural rubber.



Cellular rubber gaskets are die-cut from sheet stock. (Sponge Rubber Products Co.)

Polyacrylates have high resistance to oils and can operate at temperatures up to 250 F constantly, 400 F intermittently, but behave poorly when subjected to cold. Their strengths are good and they have excellent resistance to sunlight and ozone.

Silicone Rubbers possess outstanding resistance to temperature, being capable of operating without deterioration at 300 to 350 F continuously and up to 500 F intermittently. Elasticity is retained at temperatures as low as —70 to —100 F. These materials are highly resistant to water and fair in petroleum oils, but swell upon exposure to aromatic solvents. High costs makes silicone rubbers strictly specialty materials.

Cork Compositions

Cork is one of the most widely used gasketing materials. It is the only known substance that is truly compressible with no side flow under load. Its coefficient of friction is high whether wet, dry or oily. Since the material is compressible, however, the friction characteristics are not critical. Cork is not recommended for sealing gases. Liquids under moderate pressures can be sealed satisfactorily at temperatures of up to 250 F. Imperviousness increases with the density of cork. Resiliency increases with the particle size, other factors being equal, but large particle size gives greater porosity, a softer material, and rougher finishes. Despite these disadvantages, corks with large particle size are preferred for gasketing because of their greater resilience.

The chemical properties of straight cork compositions are, to a certain degree, derived from the binders used. Glue-glycerine compositions normally are used to obtain good resistance to oil, grease and gasoline. Synthetic resin binders provide good water and mold-growth resistance, while protein binders consisting of blood albumen yield a composition with properties similar to those of natural cork, which can be used for frictional services and polishing wheels. Cork compositions, as a rule, provide excellent resistance to oils and are the cheapest materials for sealing these fluids in the normal ranges of temperature and pressure. Both alkalies and strong acids are detrimental to cork and it is not recommended for use with these agents or with live steam and high pressures.

Cork can often be used in situations ordinarily prohibitive to pure cork by using special treatments. These treatments include coating with oil or graphite to reduce initial friction, with synthetic rubber, resin or glue for imperviousness against various liquids and certain gases, and laminating with cloth, treated paper or fiber for added mechanical strength.

The basic material is often combined with rubbers to give compounds with properties in between those of the two constituents. Such materials have the desirable compressibility of cork plus the impervious qualities of synthetic rubber.

Cork is available for gasketing in sheet or slabs 24 in. by 36 in. and larger, and up to several inches thick. It may possibly be obtained in even larger sizes. Gaskets are usually die cut or machine shaped from sheets.

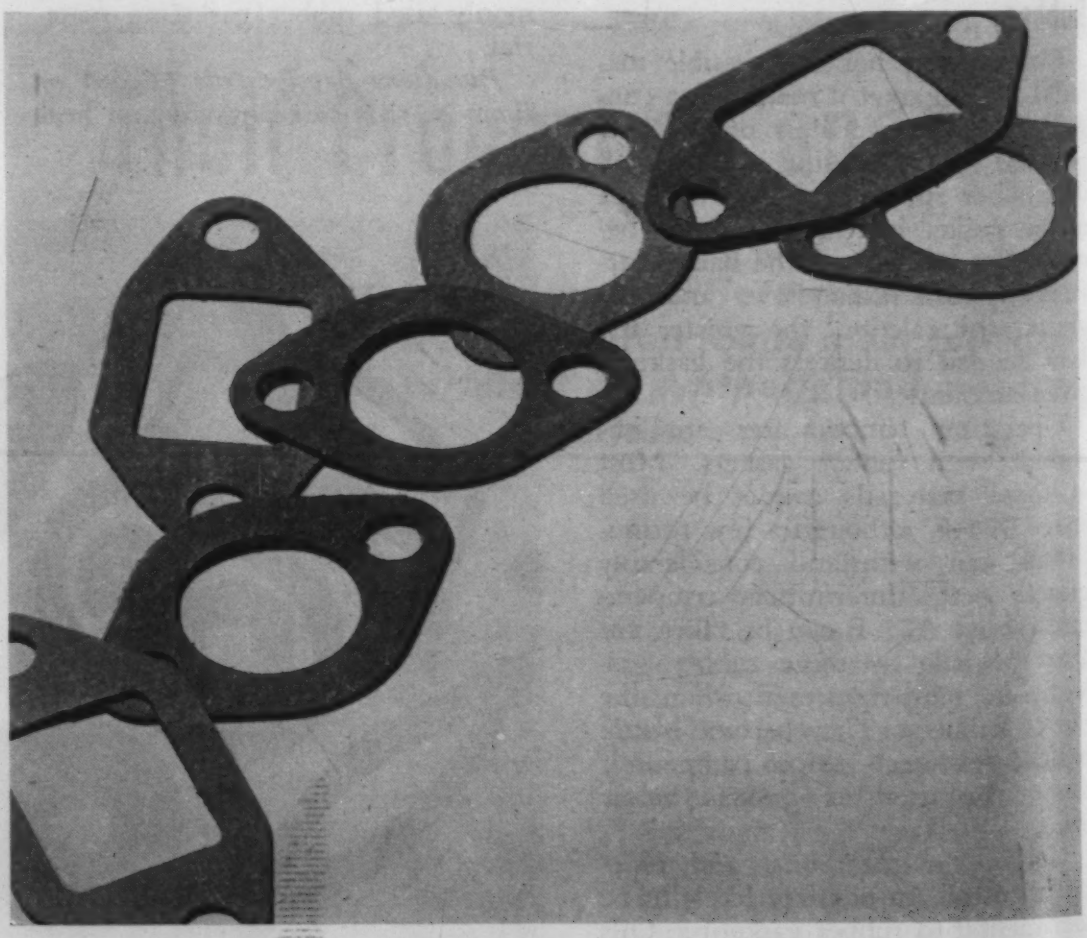
Plant Fibers

Fiber sheet materials made from fibers of kraft paper, hemp and jute are widely used as gasketing for sealing oil, gasoline, water and other liquids at relatively low temperatures. The material is purposely made porous at first so that it can be saturated and tanned to make it impervious. Usually the impregnants consist of solutions of glycerin-gelatin or natural or synthetic rubber. Often granulated cork is incorporated to increase both porosity and compressibility.

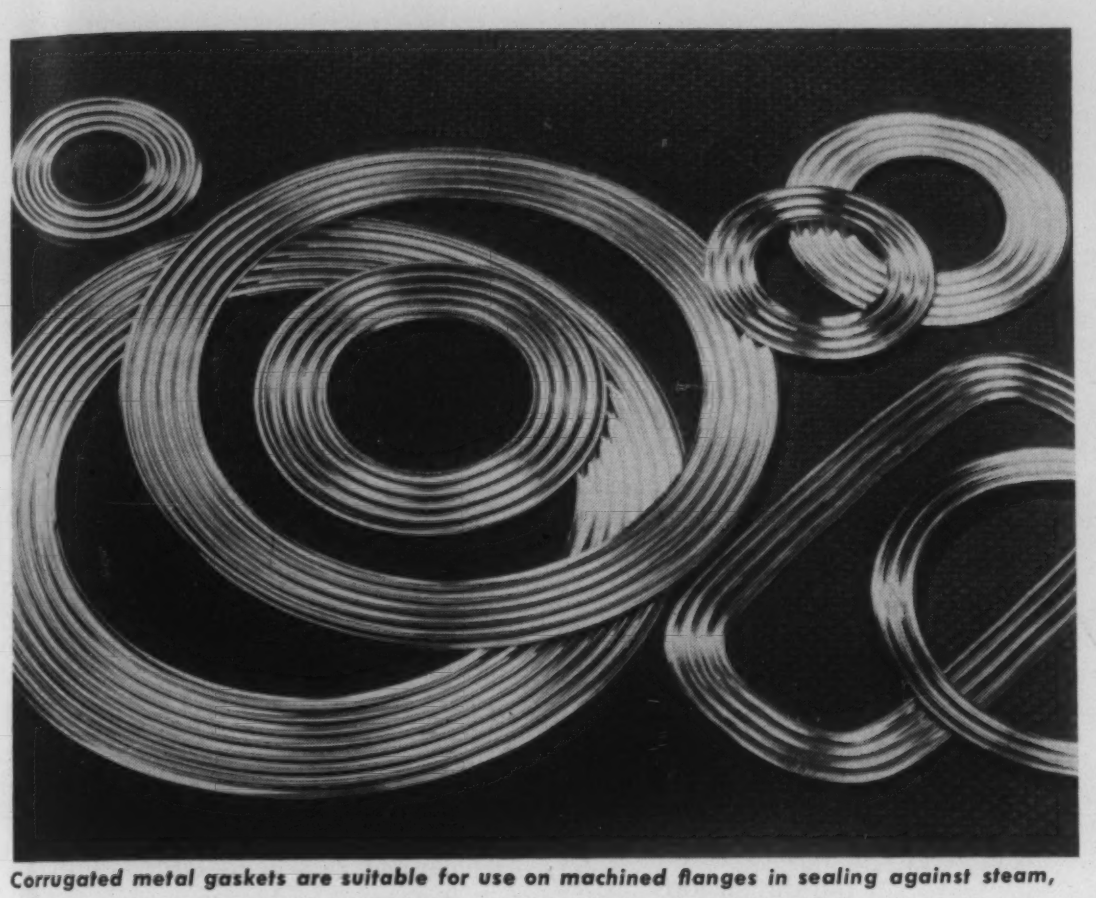
Fiber materials are fairly hard and give good dimensional accuracy, but have poor dimensional stability. They have relatively high strengths and are widely used at temperatures up to 220 F. They are available in sheet form or as ready-made gaskets die cut from the sheet. Their resistance to oils and solvents is very good, making them useful in many places rubbers cannot be applied.

Asbestos Fibers

Asbestos is used in sheets consisting of the compressed asbestos fibers with a suitable binder to meet the chemical and temperature requirements. It has a relatively low compressibility by comparison with that of cork. The compressibility depends upon the binder, to a large extent, and upon the degree to which the material is compressed originally. It has good recovery. Of course, its heat resistance is the property which makes it one of the most common high temperature gasketing materials. As a general rule, it is recommended for temperatures



Asbestos fibers with suitable binders are used for gasket materials exposed to temperatures up to 850 F. (Rogers Corp.)



Corrugated metal gaskets are suitable for use on machined flanges in sealing against steam, water, gas, oil, acids and chemicals. (Johns-Manville)

between the upper ranges of cork and rubber and 850 F. Relatively pure asbestos papers and mill board are also used with high temperature gases at pressures up to about 100 psi.

There are two types of asbestos gasket materials. Chrysotile, a hydrated magnesium silicate, is useful where steam, air, gas, oils and brine are to be sealed at elevated temperatures. Crocidolite, or blue asbestos, while having a tendency toward less uniform fibers, contains much less water of crystallization than chrysotile and is highly resistant to strong acids and alkalies.

Asbestos is very often combined with metal, the metal being wrapped around the asbestos. This gives added protection against chemical and thermal action and retains the greater compressibility afforded by the asbestos.

Metals

Metals are chiefly used for gasketing at high pressures and high temperatures. The metals used include copper, soft iron, various stainless steels, monel metal, nickel, tin, aluminum and lead. Of these, probably soft iron and copper are the most important.

Metals require special treatment to make efficient seals. Where ordinary gasket materials conform to the contours of the flange surfaces, metals are hard and must be compressed to the point where they plastically flow. This requires a very high initial pressure, which must be allowed for in the bolt design. Once the metal has made good contact with the flange surfaces, it is only necessary to maintain a residual gasket pressure which generally does not approach the elastic limit. Below the elastic limit the elasticity of most metals is sufficiently great to provide the recovery characteristics required. The high strength, heat resistance, imperviousness, elasticity and rigidity of metals make them outstanding materials provided they are not too difficult to make flow cold.

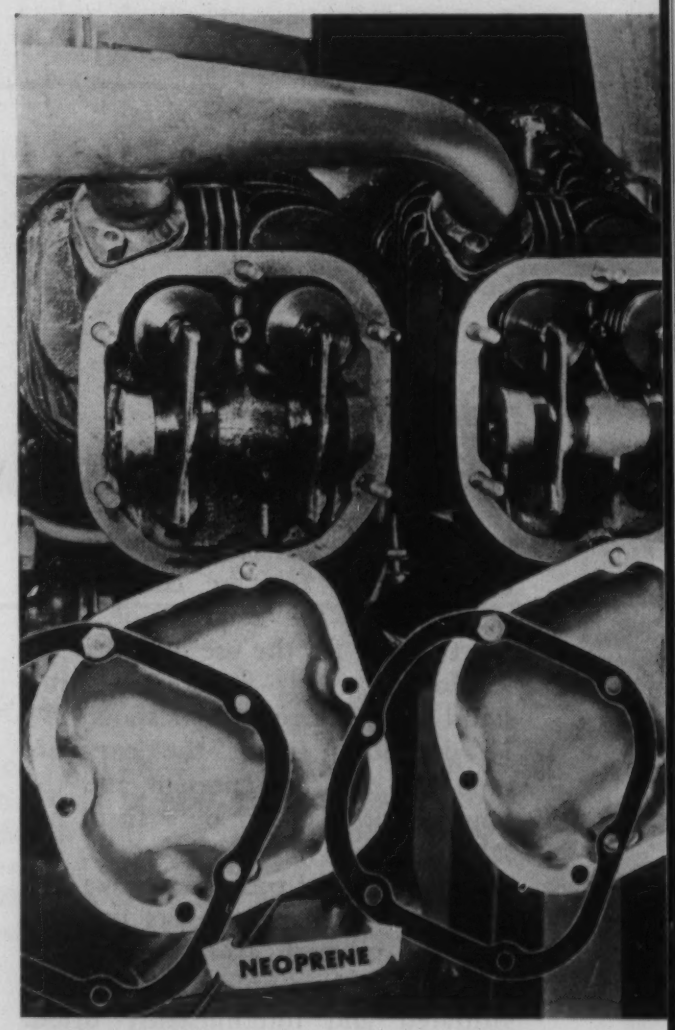
The fairly wide choice of metals enables the use of a metal to meet most chemical conditions that are encountered. If circumstances require the use of a metal with relatively low corrosion resistance, it is often possible to plate the gasket with a more resistant material. When using metallic gasketing, the chance of galvanic corrosion between dissimilar metals must also be considered wherever an electrolyte and dissimilar metals are in contact.

Plastics

Thermosetting plastics are limited somewhat as gasketing materials by their great hardness. Phenolics, ureas and melamines are often combined with other materials in high temperature gaskets.

The thermoplastics are limited in gasket applications by their poor characteristics when heated. Two outstanding exceptions are the fluorocarbon type plastics, Teflon and Kel-F. They are practically inert chemically, making them excellent materials for chemical applications. Their mechanical characteristics closely approximate those of the best grades of rubber-bonded compressed asbestos. They differ from these materials, however, because they are compressible and flow only to a limited extent during the first few hours of compression. Increased temperatures as well as increased loads produce greater cold flow. Both materials have a high softening temperature which enable them to operate with high mechanical strength from —90 to 500 F in continuous service. They are unaffected by water, and will not stick to anything. The principal drawback is high cost.

Certain vinyl plastics can be plasticized to a rubber-like consistency and fabricated like rubber without the need for vulcanizing. They have found limited application as gaskets in molded, sheet and cut forms.



Neoprene has good all-around resistance to oils, chemicals, sunlight, weather and ozone. (E. I. du Pont de Nemours & Co., Inc.)

Leather

Leather gasketing is widely used in aircraft for housing covers and certain parts of the landing gear. Since ordinary leather is somewhat porous and may permit seepage under pressure, it is treated with an impregnant resistant to the chemical conditions it is intended to meet. The first impregnants used were waxes. These were unsatisfactory for temperatures above the melting points of the waxes where pressures encountered were fairly high and where the fluids sealed were fairly thin. Resin impregnants are also used, but these leathers have their limitations and can only be produced in a "V" shape.

The most recent development has been that of a synthetic-rubber-impregnated leather combining the sealing qualities of rubber and the low friction, long life and anti-extrusion qualities of the leather. This makes the leather itself the limiting factor in temperature considerations and raises the working temperature to 225 F and pressures to 5000 psi. These gaskets are not recommended for water or oxygen service but are useful for oil and air applications. Leather washers are not recommended for steam, acids or alkalies.

While leather is harmless to most materials, it contains certain salts which pit stainless steels. All types of leather contain these salts and, unless special impregnants are used to counteract them, leather is not satisfactory for use with these metals.

Felt

Felt is usually used in gasketing with an impregnant of rubber, resin, plastics, wax or graphite. Felt alone is resilient, compressible and strong, but is not impermeable. The properties of the felt are considerably modified by the impregnant. The chief reason for the use of felt is for reinforcing. Felt fibers will withstand temperatures up to about 275 F, depending upon the exposure time, the moisture present and the impregnant. Felt in pure form has relatively high resilience and no lateral flow even at pressures above 20,000 psi. Wool felt resists medium strength mineral acids and dilute mineral solutions unless continuously saturated and intermittently dried. Untreated, it will resist the actions of oils, greases, waxes and most solvents. Felts with a substantial amount of cotton should not be subjected to mineral acid solutions, while alkalies damage wool felts. Felt materials are available for gasketing in sheets from which the gaskets are die cut.

Joint Design

One of the primary considerations in choosing a gasket material is the type of joint to be used and the characteristics peculiar to it. There are three ways in which the gasket can be inserted: confined, partially confined and unconfined. If the gasket is to be confined, it is well to choose (within the limitations of the material) a truly compressible substance, such as cork, whose volume will shrink with increasing load. Rubber would defeat the design because its incompressibility would cause it to flow out of the confined area unless the confining area were made large enough to accommodate the change in the dimensions.

Close-tolerance joints requiring gaskets of precise dimensions necessitate hard, thin gaskets of paper and vegetable fiber which will not deflect to any great extent, yet seal satisfactorily.

The finish of the bearing surfaces is another consideration. If the finish is rough machined or cast to broad tolerances, a fairly resilient material, such as cork or rubber, is desirable to maintain a tight seal. Where metallic gaskets are indicated, the surface finish should be relatively smooth. Also important is the coefficient of friction of a finished flange. A fairly rough surface having a high coefficient of friction will make the deformation of rubber a great deal more difficult than will a high finish. Rubber-like, incompressible materials are far more influenced by friction than are truly compressible materials, which always compress the same amount for a given load. Friction also assists in preventing gasket blowouts. Therefore, the lower the coefficient of friction, the greater should be the area of the gasket, or the unit load (if this is not maximum), to compensate for the loss in the hold of the gasket.

The most common joint is the flange-type. This joint is well suited to practically any type of gasket material and, in the light of previous discussion, little more need be said.

A second, increasingly popular joint is the telescope joint. This is most often used in joining two cylinders of different diameters. The gasket is placed between the cylinders, and the gasket pressure is exerted at right angles to the bolt load. The pressure is derived solely from the initial deformation occasioned by the placement of the gasket and any slight additional swelling which might be caused by contact with the fluid to be contained. The gaskets for such joints are cylindrical and somewhat thicker than gaskets used in flange joints.

Due to the thickness of the gaskets, the bolts must be assumed to support some of the fluid pressure exerted against them. At such thickness, the gasket material has a tendency toward a shearing action which is transmitted to the bolts. In many joints, the gasket pressure vertical to the bolts is increased by placing the gasket in a stuffing box and applying pressure with a gland. The best results as far as sealing is concerned can be obtained with an incompressible substance such as rubber or many of the synthetic rubbers. Only such materials can transform a verticle pressure into a horizontal one.

The third type of joint to be found in certain applications is the pressure-seal joint. This is a self-energized type which seals, partly due to the initial deformation of the gasket in being placed in position and partly by fluid pressure. The primary consideration in choosing a material for this type of joint is that it be resilient for long periods while in contact with the fluid to be retained. Here again rubber or rubber compounds are the best materials, but final choice rests on the type of fluid to be sealed and the service conditions.

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Distillation Products Industries, Div. of Eastman Kodak Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
The Felt Assn.
The Felters Co.
Firestone Industrial Products Co.
The Garlock Packing Co.
Greene, Tweed & Co.
E. F. Houghton & Co.
Johns-Manville Sales Corp.
Linear, Inc.
Raybestos-Manhattan, Inc.
Rogers Corp.
The Sponge Rubber Products Co.
United States Gasket Co.
United States Rubber Co.

Tool Steels: Types Treatments

MATERIALS & METHODS MANUAL No. 85

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

AUGUST 1952

by T. C. DuMond, Editor, Materials & Methods

Slightly more than 0.1% of the steels produced in this country are in the group generally called tool steels. Although there are several methods of classifying tool steels, a grouping according to use characteristics seems most satisfactory. Such a grouping permits the engineer to select a tool steel, despite the maze of trade names, that will best fit his needs. This Manual covers:

- ***Classes of Tool Steels***
- ***Factors in Selecting Proper Tool Steel***
- ***Heating and Heat Treatment***

Introduction

The designation "tool steel" is applied to a rather large and complex group of steels which have been developed over the years, primarily to form other materials. While it is relatively easy for trained metallurgists to choose tool steels for specific applications, these materials can become extremely complicated to those who encounter them less frequently or who do not know how the various alloying elements affect the properties of tool steels.

There are other reasons for the confusion which exists. However, the chief stumbling block in a better understanding of tool steels is the fact that there are so many proprietary names and compositions that defy attempts to do anything more than categorize the steels. In other words, it is seldom that a direct comparison can be made between tool steels because the recipe for each steel varies slightly from maker to maker.

Perhaps the easiest way to understand tool steels is by learning the answers to a few questions, such as:

What are tool steels?

Technically, a tool steel is one that is used to remove metal in machining operations. Actually, the name is applied to those steels developed for die and mold work as well.

How do tool steels differ from other steels?

In addition to their compositions, tool steels differ from other steels primarily in the way they are made. All tool steels are electric furnace products and are considered to be the highest quality steels made. Most tool steels offer a combination of a tough core and a hard case.

Does care in composition and manufacture provide any special qualities in tool steels?

Yes. Tool steels have built into them the following properties: All have high impact strength, high fatigue resistance, high hardness, good resistance to wear and abrasion, and good heat treatability. Of course, these properties vary in tool steels, some steels being outstanding in certain of the properties.

What factors are involved in the satisfactory use of tool steels?

In order to obtain long serviceable life from tool steels, the parts made from them must be designed properly, made accurately, the proper steel must be selected and, finally, the steel must be heat treated correctly.

What is the best method of selecting a tool steel?

For ordinary uses, it is probably best to start with a simple carbon tool steel. If service conditions show that the steel does not stand up well, then a more highly alloyed steel should be selected, one with the special properties that are most needed.

How are tool steels classified?

There are several ways in which tool steels are grouped. Some classify them according to the quenching media used with the steels. In this category are to be found water hardening steels, oil hardening steels and air hardening steels.

A second means of grouping tool steels is by alloy content. Here we find carbon tool steels, medium alloy tool steels, high alloy tool steels and high-speed steels.

Still another method of grouping is based largely on the end use characteristics of the steels. This grouping breaks down into high-speed steels, hot work steels, shock resisting steels, cold work steels, and carbon and low alloy tool steels.

Where are tool steels used?

Tool steels are used in many types of applications. The most common uses are for cutting tools and for dies and molds. However, there are many other uses. For example, most chisels and quality screw drivers are made of some form of tool steels. Likewise, many machine and fixture parts are made of tool steels. Typical are indexing fingers, pawls and pins, shafts of many kinds, bushings, collets, dowels, arbors and spindles, lathe centers, springs, wrenches, ball and roller bearings, gages, knives and shears, dental burrs, and many other parts of all descriptions.

In the pages to follow, an attempt will be made to suggest the best method of approaching the problem of finding the most suitable tool steels for the applications intended. In addition, suggestions will be made as to how to get the most from the steels in heat treating, one of the most important and mishandled aspects of tool steel use.

Classes of Tool Steels

As was indicated in the introduction to this Manual, there are many different types of classifications of tool steels. Several manufacturing and using groups have tried to establish identification systems comparable to the SAE or AISI classifications for other steels, but resistance from many quarters has caused virtual abandonment of the systems.

Of all the classification systems in use, the most practical seems to be the one which groups the steels, in most cases, according to their chief service characteristics. In general, such groupings include: Carbon and Carbon-Vanadium Steels; Cold Work Tool Steels; Shock Resisting Tool Steels; Hot Work Tool Steels; High-Speed Steels; and Special Purpose Tool Steels. That is the grouping used in this Manual.

Use of the following descriptions in conjunction with the tables of properties, compositions, characteristics and uses to be found on pages 118, 119, 120 and 121 will provide a basic understanding of the various types of tool steels.

Carbon Tool Steels

The first of the tool steels to be developed were the carbon tool steels. Although these steels have been augmented by many other varieties, they are usually considered first unless there are certain service characteristics required which can only be satisfied by a more highly alloyed tool steel. Steels in this group are hardened by heating and quenching in water, and thus are often referred to as water hardening tool steels.

The carbon tool steels fall roughly into three subdivisions, according to the carbon content. All have a carbon content ranging from 0.70 to 1.40%. These steels have small percentages of manganese, silicon and chromium according to the hardenability requirements. Some of the high carbon content carbon tool steels also have vanadium added.

Those steels of this class with car-

bon in the lowest range are used where shock resistance is the major consideration; those in the medium carbon range are the general purpose category, while those having the highest carbon content are used in applications requiring the greatest abrasion resistance and where keen cutting edges are needed.

These, in general, are the service characteristics of the carbon tool steels:

They have the best machinability ratings of all the tool steels and are the best in respect to decarburization. In other words, they are not highly susceptible to loss of carbon from the surface during heating. Toughness is good, wear resistance ranges from fair to good, but their resistance to heat is classed as poor. Carbon tool steels are the hardest of tool steels.

Carbon tool steels are subject to deformation in heat treating, but can be hardened with relative safety from cracking when properly heated and quenched. The depth of case on the carbon tool steels is relatively shallow as compared to steel in the other tool steel groups.

The carbon, or water hardening, tool steels should not be used when any of the following conditions are involved: where complete safety in hardening is required; where dimensional change in heating must be kept to a minimum; where maximum wear resistance is necessary; where maximum toughness or shock resistance is needed; or, where red hardness is paramount.

These steels are used for many kinds of tools and parts, including such products as: battering tools, chisels, chuck and vise jaws, knives, drawing dies, bushings, lathe centers, and many other cutting and forming tools.

Cold Work Tool Steels

Steels which are grouped in the cold work class are basically carbon tool steels to which have been added small quantities of alloying elements. However, there are in this group steels which contain carbon up to as high as 2.30% and as much as 13.00% chromium. All steels in this group contain manganese and silicon, must have chromium, vanadium and molybdenum, and others contain small quantities of tungsten, nickel and cobalt. Many consider this to be the most important group of tool steels because the majority of uses can be served by one or more of the steels in this classification. They are most generally selected for blanking and cold forming operations.

The lower alloy steels of the cold work group are of the oil hardening type, while those having high alloy contents fall into the air hardening class.

Machinability of the cold work steels ranges from fair to poor, with this property falling off among those having the greatest alloy content. The cold work steels have good wear resistant properties, and in some cases offer the best wear resistance of all tool steels. They are reasonably tough, but only have fair to poor heat resistant properties.

Cold work tool steels are relatively easy to handle in heat treating and do not distort readily nor expand or shrink unduly. They are classed as medium to deep hardening and attain hardnesses of from 62 to 66 Rockwell C.

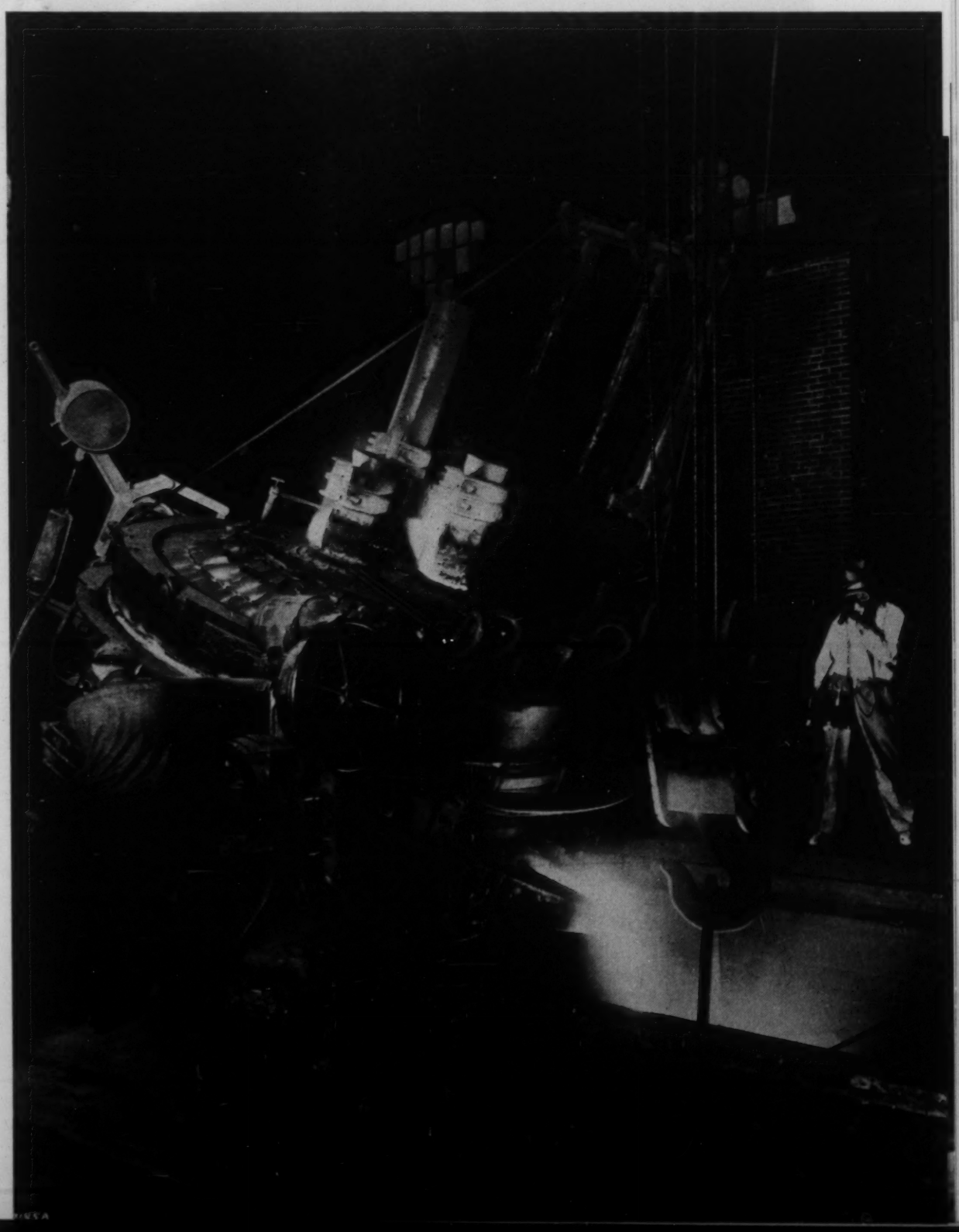
Certain of the cold work tool steels offer the best combination of properties of all tool steels, which leads to their being categorized as the most important group of tool steels.

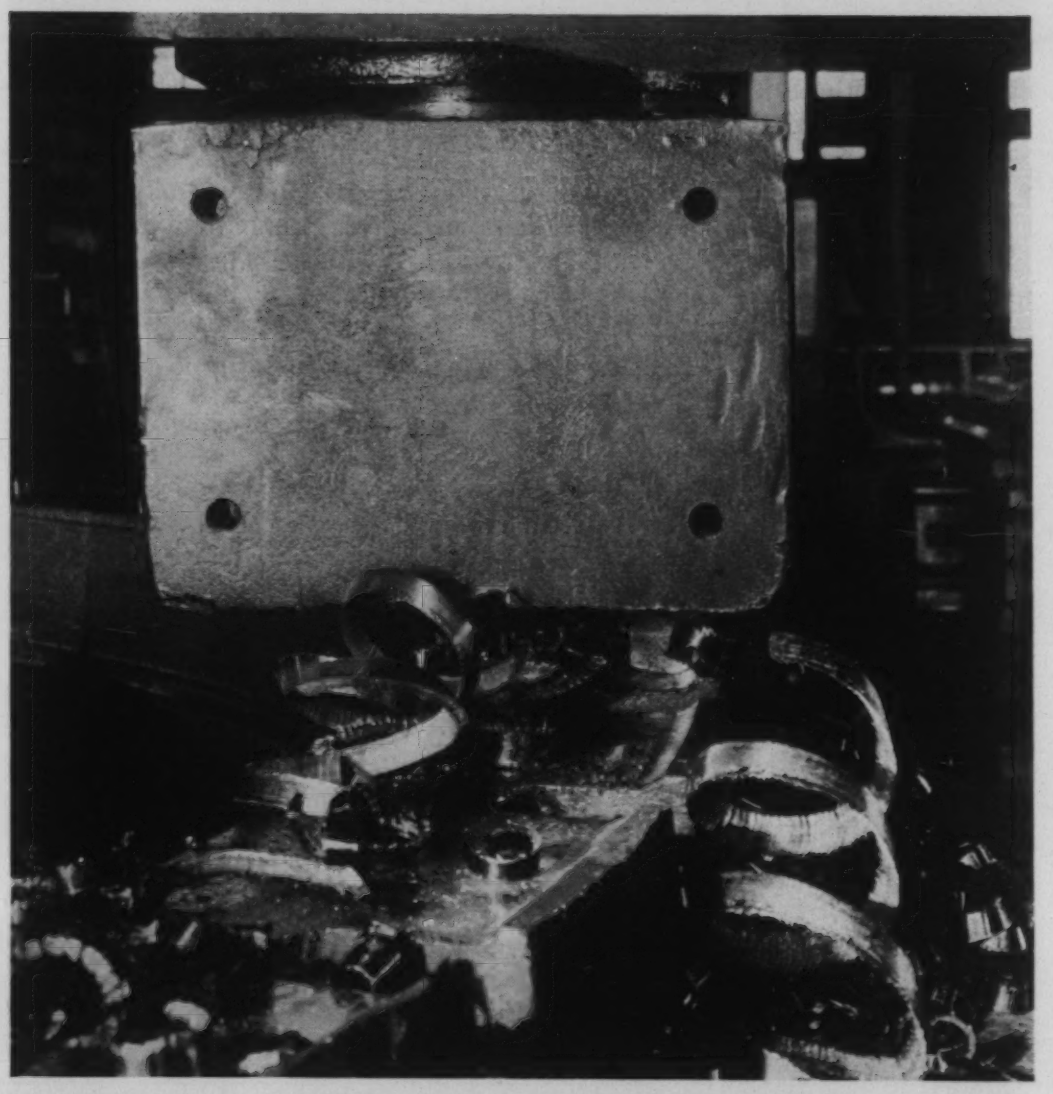
Steels of the cold work type are used for all kinds of cold blanking, forming and trimming dies, spindles, rolls, spinning tools, gages and many cutting tools.

Shock Resisting Tool Steels

As their group name implies, the shock resisting tool steels have been developed for those applications where the most needed property is the ability to stand up under repeated shock. As would be expected, steels in this group are extremely tough. They are relatively low in alloy content and the carbon content is also extremely low, ranging from 0.45 to

The properties of tool steels are a result of the care taken in their manufacture as well as their compositions. Tool steels are made in electric furnaces under carefully controlled conditions.





For cutting applications, the high-speed steels are most frequently used because of their combination of red hardness, shock resistance and ability to retain relatively sharp edges.

0.65%. Shock resisting tool steels are all of the oil hardening type, although some of them can also be quenched in water.

Steels in this group are subject to considerable decarburization in heating, unless suitable precautions are taken, and are subject to size change and distortion in heat treating. They are classed as fair in regard to heat resistance, wear resistance and machinability. Hardness is usually kept under 59 Rockwell C.

Such parts subject to constant or repeated shock, as are punches, pneumatic tools, chisels, swages, shear blades, small forging dies and trimming dies, are usually made of the shock resisting tool steels unless additional service requirements dictate some other type of tool steel.

Hot Work Tool Steels

The requirements of hot forging and extruding, die casting and plastic molding resulted in another class of tool steels which offered good resistance to the destructive action of heat encountered in service. As might be expected, tool steels developed for this purpose are known as hot work tool steels and have better than average heat resisting properties. These steels are air hardening and have good heat treating properties.

Hot work tool steels have relatively high chromium contents, contain little carbon, and have a high total alloy content, including tungsten, silicon, vanadium and molybdenum. Carbon is kept low because of its tendency to soften and wash out under high heat conditions.

This class of tool steels is often called upon to withstand a combination of heat, pressure and abrasion and often must also resist shock. Therefore, steels so classed are rated as from fair to good in all these properties. They are deep hardening and classed as fair in their resistance to decarburization. Hardnesses range from 42 to 60 Rockwell C.

Tools which must punch, shear or form metals at high temperatures are made of the hot work tool steels, as are such parts as die holders, forging machine plungers, springs for high temperature use and heavy duty compression tools.

Special Purpose Tool Steels

There are a great many tool steels which do not properly fall into any of the usual categories and are, therefore, designated as special purpose tool steels. Most of the steels have been developed to handle the peculiar requirements of one certain application. Thus, they are usually more expensive for many applications than would be the more standard steels. For example, in the accompanying table can be found one low alloy steel which is outstanding in its toughness. It is used for many tools and parts that are subjected to heavy shock, such as shearing dies, thread roller dies, punches, clutch parts, pawls and indexing fingers.

Another special purpose tool steel offers the best wear resistance of all tool steels and is used for making such items as burnishing tools, wire drawing dies, forming dies and cold extruding dies.

Many of the tool steels which are normally classed with other types of tool steels, but which vary considerably in composition and properties, could well be included among the so-called special purpose tool steels. Such steels would be those specifically designed for finishing operations, which are usually high in carbon and low in tungsten and provide maximum hardness and maximum wear resistance, plastic molding tool steels, die casting die steels and special tools used in the mining and quarrying industries.

High-Speed Tool Steels

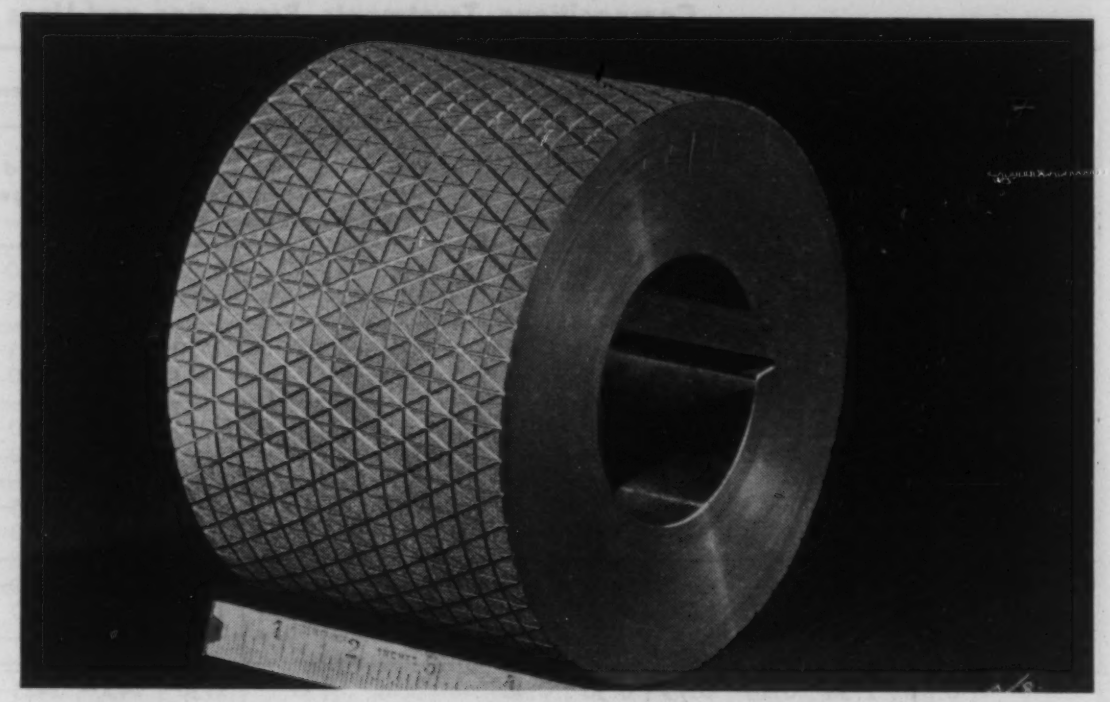
The high-speed tool steels are the most highly alloyed of the tool steels and usually contain, in addition to fairly high percentages of carbon, large amounts of tungsten or molybdenum, chromium and vanadium, and sometimes cobalt. The chief use of the high-speed steels is in the making of cutting tools. Compositions of the high-speed steels are designed to provide excellent red-hardness and reasonably good shock resistance. Even though they work efficiently as cutting tools, the high-speed steels are not noted for maintaining keen edges, although there are exceptions.

Steels of the high-speed family keep their sizes well in hardening and can be quenched in oil, air or molten salts, depending upon the size, shape and requirements of the parts. High-speed steels are rated as deep hardening and most have

fair to good toughness, good to exceptional heat resistance, good wear resistance, and fair machinability. Most of them have as quenched hardnesses of from 64 to 66 Rockwell C.

Several of the high-speed steels are known as 18-4-1, 18-4-2 and 18-4-3 steels, denoting the content, respectively, of tungsten, chromium and vanadium in percentages. The 18-4-1 steels are used for most kinds of cutting tools, 18-4-2 steels are often used for taking light cuts at high speeds, and the 18-4-3 steels are well suited to taking heavy cuts on metal machining. One 18-4-2 steel with considerable cobalt in the composition is intended for machining extra hard materials, such as heat treated parts and chilled rolls.

Beside their cutting applications, the high-speed steels are used for making extrusion dies, burnishing tools, and blanking punches and dies.



An oil hardening tool steel was selected for making this embossing die for forming aluminum. In addition to generally good cold working properties, the oil hardenng steels can be given and will retain good, sharp edges.

Die casting dies, such as the 16-cavity die illustrated, must be made of hot work die steels, which, in addition to withstanding the heat of molten die casting metals, must resist wear, abrasion and heat checking.

Compositions, Treatments, Properties and Uses of Tool Steels

	Chemical Composition, %								Heat Treatments						Service Characteristics			
	C	Mn	Si	Cr	V	Mo	W	Others	Quench Media	Forg. Range, F	Anneal Temp, F	Hard Range, F	Norm. Temp, F	Draw Temp, F	Non-Deform.	Safety in Hard.	Toughness	Heat Res.
Work Hardening Tool Steels	0.85–0.95	Adjusted for hardenability requirements			—	—	—	—	W	1750–1800	1450–1500	1450–1525	1450	325–450	Poor	Fair	Good	Poor
	0.95–1.10				—	—	—	—	W	1750–1800	1425–1475	1425–1500	1600	325–450	Poor	Fair	Good	Poor
	1.10–1.30				—	—	—	—	W	1750–1800	1375–1425	1400–1450	1600–1800–	325–450	Poor	Fair	Good	Poor
	0.95–1.10				0.15–0.35	—	—	—	W	1800–1900	1375–1425	1425–1500	1600	325–450	Poor	Fair	Good	Poor
Cold Work Tool Steels	0.85–1.05	1.00–1.40	0.15–0.40	0.40–0.60	0.30 max	—	0.40–0.60	—	O	1800–1900	1400–1450	1450–1500	1600	350–450	Good	Good	Fair	Poor
	0.85–1.05	1.50–1.80	0.15–0.35	0.75 max	0.30 max	0.40 max	—	—	O	1750–1800	1450–1500	1425–1475	1550	350–450	Good	Good	Fair	Poor
	1.35–1.55	0.30–1.00	0.75–1.25	—	—	0.20–0.30	—	—	O	1800–1950	1400–1500	1450–1525	1650	400–600	Good	Good	Fair	Poor
	0.90–1.05	0.30–0.90	0.15–0.35	4.75–5.50	1.00 max	0.90–1.25	—	—	A	1950–2000	1550–1600	1775–1825	Do not	400–500	Best	Best	Fair	Fair
	1.40–1.60	0.20–0.60	0.20–0.60	11.00–13.00	1.00 max	0.70–1.10	—	Ni+Co 0.60 max	A	1900–1950	1600–1650	1800–1850	Do not	400–600	Best	Best	Fair	Fair
	2.00–2.30	0.20–0.60	0.20–1.00	11.00–13.00	1.00 max	1.00 max	1.00 max	Ni+Co 0.60 max	O	1850–1900	1600–1650	1725–1775	Do not	400–600	Good	Good	Poor	Fair
	1.40–1.60	0.20–0.60	0.20–0.60	11.00–13.00	1.00 max	0.70–1.10	—	Ni 0.60 max Co 2.70–3.50	A	1950–2000	1600–1650	1800–1850	Do not	400–600	Best	Best	Fair	Fair
Shock Resisting Tool Steels	0.45–0.55	0.15–0.40	0.15–1.20	1.10–1.75	0.15–0.30	0.60 max	2.00–3.00	—	O	1800–1900	1450–1550	1700–1800	Do not	400–600	Fair	Good	Good	Fair
	0.45–0.55	0.30–0.50	0.90–1.20	—	0.50 max	0.30–0.60	—	—	W O	1900–2000	1450–1500	1525–1575 1575–1625	1600	350–450	W Poor O Fair	W Poor O Good	Best	Fair
	0.50–0.65	0.60–1.00	1.75 2.25	0.35 max	0.30 max	0.30–0.60	—	—	W O	1850–1950	1425–1475	1625–1650[2] 1550–1600[3]	1600	350–900	W Poor O Fair	W Poor O Good	Best	Fair
Hot Work Tool Steels	0.35–0.40	0.25–0.50	0.80 1.20	5.00–5.50	0.40–0.80	1.20–1.50	—	—	A	1900–2000	1575–1625	1825–1850	Do not	1050–1150	Good	Good	Good	Good
	0.32–0.38	0.20–0.50	0.80–1.20	4.75–5.50	0.50 max	1.30–1.80	1.00–1.75	—	A	1950–2050	1575–1650	1850–1900	Do not	1050–1150	Good	Good	Good	Good
	0.35–0.40	0.25–0.50	0.80–1.20	5.00–5.50	0.90–1.15	1.20–1.50	—	—	A	1900–2000	1575–1625	1825–1850	Do not	1050–1150	Good	Good	Good	Good
	0.38–0.43	0.25–0.50	0.80–1.20	5.00 5.50	—	—	4.00–5.00	Co 0.40–0.60	A	1950–2050	1625–1675	1850–1900	Do not	1050–1200	Good	Good	Good	Good
	0.28–0.35	0.15–0.40	0.20–0.50	3.00–3.50	0.20–0.60	0.60 max	8.75–10.00	—	A O	1900–2050	1600–1650	2100–2150	Do not	1150–1250	Good	Good	Good	Good

Compositions, Treatments, Properties and Uses of Tool Steels—Continued

Service Characteristics—Continued					Remarks	Typical Trade Names	Typical Uses
Wear Res.	Mach.	Depth of Case	Resist. to Decarb.	Hard.[1] Rc.			
Fair	Best	Shallow	Best	67–68	Water hardening	Pompton, XXX, Special Nall, Special, Sanderson, LaBelle Best Extra, Washington, Lion Extra, Red Label, Blue Label, Colonial, Vulcan, Sp. Fort Pitt, Alva E. S. A.	Battering tools, chisels, chuck and vise jaws, screwdriver blades, nail sets, cold punches, swaging tools, knives, heading dies, drill bushings, lathe centers, embossing dies, gages, lamination dies, slotting cutters, drawing dies, rotary slitters, thread rollers, engraver dies, cold mandrels, trimming punches.
Good	Best	Shallow	Best	67–68	Water hardening		
Good	Best	Shallow	Best	67–68	Water hardening drill rod		
Good	Best	Shallow	Best	67–68	Water hardening vanadium		
Good	Good	Med	Good	65–66	Oil hardening good cutting edges	Ketos, OTR, Saratoga, Badger, Oil Hardening, Graph-Mo, Colonial No. 6	Blanking, forming and trimming dies, taps, threading tools, circular saws, reamers.
Good	Good	Med	Good	65–66	Oil hardening	Deward, Stentor, Paragon, Sp. Oil Hardening	Blanking, forming, molding dies, collets, stamps, spindles, thread gages, master tools.
Good	Good	Med	Good	65–66	Oil hardening, good cutting edges, resists wear	Mangano, Non-Shrinkable	Reamers, broaches, taps, intricately shaped tools, gages.
Good	Fair	Deep	Good	64–66	Medium alloy air hardening steel	No. 484, Sagamore, AH-5, Airkool, Select 8, Sparta, AirHard Vuldie	Large blanking dies, precision tools, coining dies, rolls, master hubs, thread coller dies.
Best	Poor	Deep	Fair	63–65	High carbon-high chromium steel, abrasion resist., nondeform, high hardness	Lehigh H, Ontario, Airdi 150, Olympic	Swaging, shear blades, cold forming dies, thread rolling dies, punches, gages.
Best	Poor	Deep	Fair	62–64	High carbon, high chromium steel	Hampden, Lehigh S, HYCC, GSN, Huvon	Spindles, rolls, hobs, spinning tools, draw and extrusion dies, trimming dies, punches, thread gages.
Best	Poor	Deep	Fair	62–64	High carbon, high chromium cobalt steel	No. 610, Lehigh H, Airdi 150, Alidie	Blanking, forming and coining dies, edging and forming rolls, intricate punches, drawing and extrusion dies.
Fair	Fair	Med	Fair to good	57–59	Chisel steel, high str. and hardness	67-Chisel, Seminole, XL, Atha Pneu, QA, XL Chisel	Pneumatic chisels, shear blades, studs, bolts, springs, hot forming dies, small forming dies.
Fair	Good	Med	Poor	55–62	Shock-resist. silicon, manganese, moly steel, tough and strong	Solar, Trident	Punches, pins, trimming dies, wrenches, stamps, heavy duty coining dies and forming tools, knurls.
Fair	Fair	Med	Poor	61–65	Shock-resist. silicon, manganese steel, tough, takes shock	Omega, Ludlum 602 and 609, LaBelle Silicon No. 2, Lanark	Chisels, cold sets, swages, heavy duty punches, drift pins, shear blades, spring collets, machine parts.
Fair	Fair	Deep	Fair	53–56	Die casting, die steel, good high properties	VDC	Die casting dies-aluminum, zinc and magnesium.
Fair	Fair	Deep	Fair	53–56	Die casting, die steel, resist. shock and heat checking, good high temp. prop.	Cr-Mo-W, Potomac, LPD M. G. R.	Forging machine plungers, forging die inserts, brass forging and pressing dies, aluminum die cast dies.
Fair	Fair	Deep	Fair	54–56	Die casting, die steel	Cr-Mo-V, Halcomb 218, No. 883, Potomac M	Forging dies, die casting dies, aluminum extrusion dies, heavy duty compression tools.
Fair	Fair	Deep	Fair	55–58	Die steel, hard, red and tough	CCS	Backer blocks, die holders, extrusion dies and forging dies and inserts for brass press forging.
Fair	Fair	Deep	Fair	47–52	Upsetting hot work	No. 57 Hot Work, TK, CLW, Peerless A, Atlas	Hot shear blades, hot gripper dies, hot extrusion dies, die casting dies, forging dies, hot punches, bending dies.

(Continued on page 120)

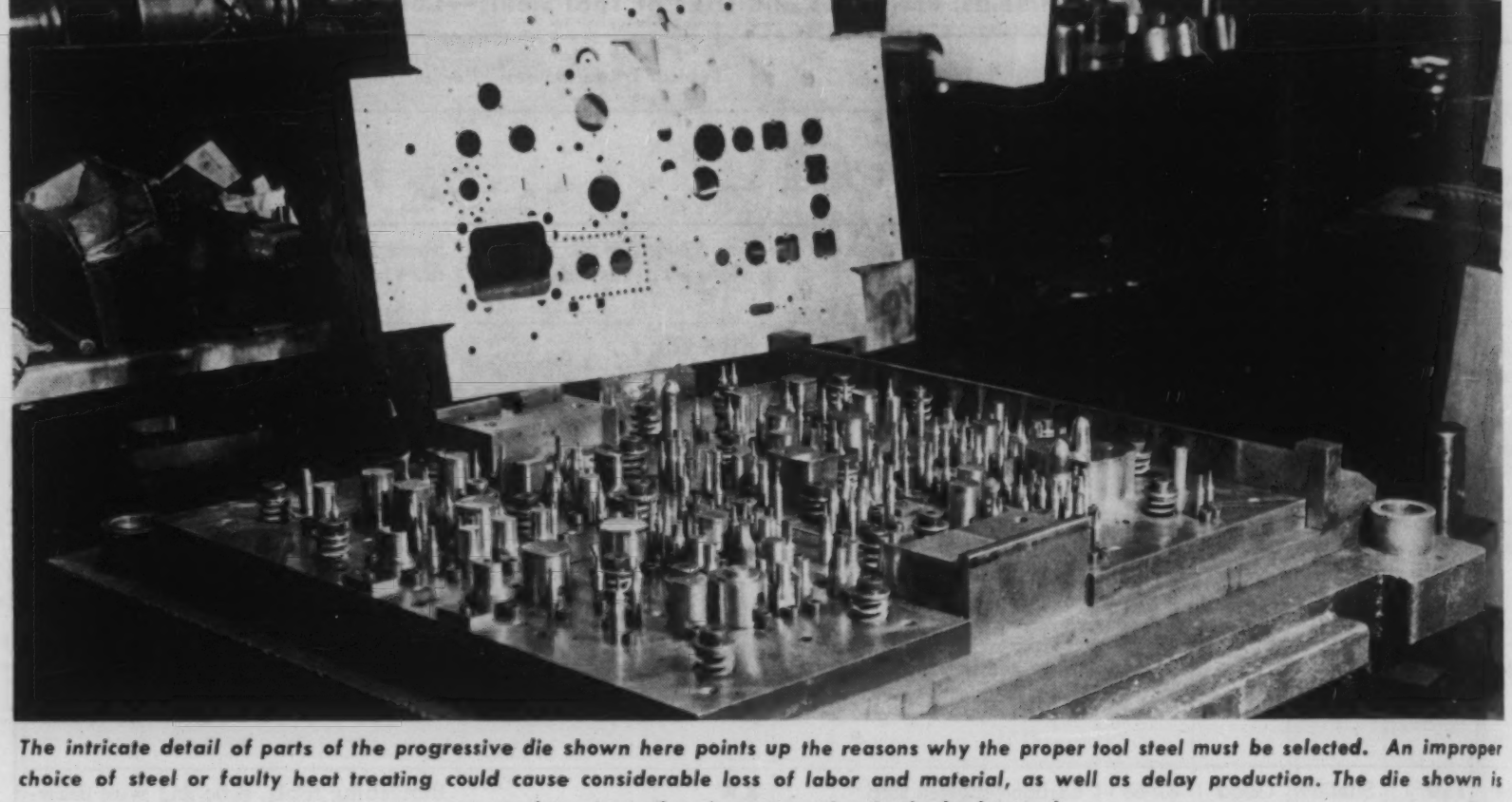
Compositions, Treatments, Properties and Uses of Tool Steels—Continued

	Chemical Composition, %								Heat Treatments						Service Characteristics				Service
	C	Mn	Si	Cr	V	Mo	W	Others	Quench Media	Forg. Range, F	Anneal Temp, F	Hard Range, F	Norm. Temp, F	Draw Temp, F	Non-Deform.	Safety in Hard.	Toughness	Heat Res.	Wear Res.
Hot Work Tool Steels —Cont.	0.48–0.53	0.15–0.40	0.15–0.40	2.50–3.50	0.40–0.60	1.00 max	14.00–16.00	—	A O	1900–2050	1600–1650	2200–2250	Do not	1100–1300	Good	Good	Fair	Very good	Good
	0.23–0.27	0.15–0.40	0.15–0.40	3.75–4.25	0.40–0.60	1.00 max	14.00–16.00	—	A O	1950–2100	1600–1650	2200–2250	Do not	1100–1300	Good	Good	Good to fair	Good to very good	Fair to good
	0.38–0.43	0.15–0.35	0.40–0.60	3.50–4.00	0.75–1.25	5.50–6.00	0.75–1.25	—	A O	1900–2050	1525–1575	2200–2250	Do not	1050–1150	Good	Good	Good	Good	Fair
Special Purpose Tool Steels	0.65–0.75	0.40–0.70	0.20–0.35	0.55–0.75	—	0.25–0.35	—	Ni 1.20–1.50	O	1850–1900	1425–1450	1450–1550	1600	350–450	Fair	Good	Very good	Poor	Fair
	0.95–1.10	0.25–0.50	0.15–0.35	1.20–1.50	—	0.30–0.50	—	—	O W	1800–1900	1450–1500	1450–1475 1500–1575	1600	400–600	Fair	Good	Fair	Poor	Good
	1.25–1.50	0.15–0.35	0.15–0.35	0.60 max	0.35 max	—	3.00–4.50	—	W	1850–1950	1525–1550	1550 1625	1650	350–425	Poor	Poor	Poor	Poor	Best
High-Speed Tool Steels	0.78–0.84	0.15–0.40	0.25–0.50	3.50–4.00	1.00–1.30	8.20–9.40	1.30–2.00	Res. 0.50 max	O, A Salt	1900–1950	1525–1575	2175–2225	Do not	1025–1125	Good	Fair	Fair	Good	Good
	0.79–0.86	0.35 max	0.40 max	3.90–4.40	1.75–2.05	4.75–5.25	6.00–6.75	Res. 0.50 max	O, A Salt	1950–2050	1550–1600	2225–2275	Do not	1025–1125	Good	Fair	Fair	Good	Good
	1.10–1.30	0.20–0.40	0.20–0.40	3.75–4.25	3.00 min	4.25–4.75	5.25–6.00	Res. 0.50 max	O, A Salt	1950–2050	1500–1550	2175–2250	Do not	1025–1125	Good	Fair	Fair	Good	Good
	1.25–1.30	0.20–0.30	0.20–0.40	4.25–4.75	3.75–4.25	4.25–4.75	5.25–5.75	—	O, A Salt	1950–2050	1600–1650	2175–2250	Do not	1025 1125	Good	Fair	Fair	Good	Good
	0.80–0.90	0.20–0.40	0.20–0.40	3.75–4.25	1.75–2.25	3.75–5.50	5.25–6.00	Res. 0.50 max Co 7.50 min	O, A Salt	1950–2050	1550–1600	2240–2280	Do not	1025–1125	Good	Fair	Fair	Best	Good
	0.68–0.75	0.15–0.35	0.20–0.40	3.75–4.25	1.00–1.25	1.00 max	17.50–18.50	Res. 0.50 max	O, A Salt	1900–2100	1600–1650	2250–2350	Do not	1000–1100	Good	Good	Good	Good	Good
	0.80–0.85	0.15–0.35	0.20–0.40	4.00–4.75	2.00–2.50	1.00 max	1800–1900	Res. 0.50 max	O, A Salt	1950–2050	1600–1650	2300–2375	Do not	1000–1100	Good	Good	Good	Good	Good
	1.00–1.10	0.15 0.35	0.20–0.40	4.00 4.75	3.00 min	1.00 max	18.00–19.00	Res. 0.50 max	O, A Salt	1950–2050	1600–1650	2250–2300	Do not	1000–1100	Good	Good	Good	Good	Good
	0.75–0.85	0.15 0.35	0.20–0.40	4.00–4.75	1.25–2.25	1.00 max	18.00–19.00	Co 7.50 min Res. 0.50 max	O, A Salt	2000–2100	1650–1680	2375 2450	Do not	1000–1150	Good	Fair	Fair	Best	Good

[1] *As quenched.*
[2] *Oil quenched.*
[3] *Brine quenched.*

Compositions, Treatments, Properties and Uses of Tool Steels—Continued

Service Characteristics—Continued					Remarks	Typical Trade Names	Typical Uses
Wear Res.	Mach.	Depth of Case	Resist. to Decarb.	Hard.[1] Rc			
Good	Fair	Deep	Fair	56–60	Upsetting hot work, good, red hardness	No. 57 Hot Work Special, Mohawk, Peerless LCT, CHW	Shear blades and cutoffs, punches, hot drawing dies, brass extrusion dies.
Fair to good	Fair	Deep	Fair	42–45	Upsetting hot work, good, tough and wear resist.	EHW No. 1	Hot heading dies, springs for high temperature use. General hot work.
Fair	Fair	Deep	Poor	56–60	Upsetting moly-hot work, high temp, hot work, shock, wear and abrasion resist.		Hot headers, temperature rivet sets, gripper dies, hot shear blades.
Fair	Fair	Med	Good	64–65	El. for.-low alloy steel	RDS, Bethalloy	Hubs, indexing pins, shear blades, swaging dies, spindles, slitting shears, fingers, thread roller dies, forming rolls, collets, punches, clutch parts, pawls.
Good	Fair	Med	Good	64–66	Gage and bearing steel	——	——
Best	Fair	Shallow	Good	67–68	Carbon-tungsten steel	KW	Burnishing tools, tube and wire drawing dies, cold extruding dies, reamers, forming dies, piercing punches.
Good	Fair	Deep	Poor	64–66	High speed, red hardness and wear resistance	HM, LMW, Rex TMO, Electrite Tatmo	Cutting tools, roll turning tools, extrusion dies, burnishing tools, thread chasers, blanking punches and dies.
Good	Fair	Deep	Fair	64–66	High speed, red hardness, wear resist. in cutting tools	Rex M-2, DBL-2, Electrite Double 6	Cutting tools, roll turning tools, extrusion dies, burnishing tools, thread chasers, blanking punches and dies.
Good	Fair	Deep	Fair	64–66	6-5-4-3 high speed, tough	Electrite MV-3	Machining abrasive materials such as plastics and some nonferrous metals.
Good	Fair	Deep	Fair	64–66	High speed steel, tough, low temp.	Electrite MV-4	Machining scaled and sandy casting, stainless irons and steels, plastics, nonferrous metals.
Good	Fair	Deep	Poor	64–66	6-5-4-2, cobalt, high speed	Speed Star, Panther Sp., 66 High Speed	Machining scaled and sandy casting, stainless irons and steels, plastics, nonferrous metals.
Good	Fair	Deep	Good	64–66	18-4-1, high speed	Star Zenith, Rex AA, LXX Electrite No. 1, Wolfram.	Lathe and planer tools, drills, taps, reamers, form cutters, thread chasers, end mills, gear cutters, wood knives.
Good	Fair	Deep	Good	64–66	18-4-2 high speed, good shock resistance	Electrite No. 19, Comokit, Panther Special	Cutting tools (light, high-speed work).
Good	Fair	Deep	Good	64–66	18-4-3 high speed, keen cutting edge	Red Tiger	Cutting tools (heavy cuts).
Good	Fair	Deep	Poor	64–66	18-4-2 cobalt, high speed, stands extreme wear and abrasion	Super Panther, Electrite Cobalt, Rex AAA, Wolfram Cobalt.	Cutting tools for machining hard materials (heat treated parts, chilled rolls, etc.).



The intricate detail of parts of the progressive die shown here points up the reasons why the proper tool steel must be selected. An improper choice of steel or faulty heat treating could cause considerable loss of labor and material, as well as delay production. The die shown is used to pierce the piece appearing in the background.

Factors in Selecting the Proper Tool Steel

The aim in selecting a tool steel for a given application is to pick a steel which will do the job, be easy to handle as far as fabricating and treating are concerned, and which represents the most economical investment. There are hundreds of tool steel names on the lists of makers and suppliers of tool steels, which leads to considerable confusion among those who must choose these steels. A simple means of selection has been the longtime aim of large users of tool steels, but that goal still seems to be remote.

Some makers have developed ingenious charts and selectors to aid the user. While these are handy devices when the steels of that particular producer are under consideration, they do nothing to group the myriad trade names into any reasonable groupings that could serve as a basis of comparison in making selections. Although there are 40 or more standard grades of tool steels, one maker promotes the idea that only 12 are needed to serve the bulk of industry's requirements. Some users feel that even less could do the job.

In lieu of any simple method of selecting a tool steel, it is necessary that the prospective user should make his selection only after a careful correlation of the basic requirements of the tool or part to be made and the metallurgical characteristics of the steel under consideration.

The requirements of many prospective uses could readily be filled by several individual steels and, in some cases, by two or more families of tool steels. When such a situation exists, there are three factors upon which the final decision should be made. They are: expected productivity, ease of fabrication, and cost.

Operations and Their Requirements

Most tool steels, with the exception of those to be made into machine parts, involve one of the following types of operations: cutting, shearing, forming, drawing, extrusion, rolling or battering. When cutting is the chief function of the tool steel, it should have high hardness as well as good heat and wear resistance.

If the action is primarily that of shearing, there must be a balance between wear resistance and toughness (depending upon the tool's design, thickness of stock, and the temperature of the operation).

In forming operations, including drawing, extruding and rolling, the tool steels must have high toughness, high strength and, in many cases, must have a maximum of resistance to heat softening.

Toughness is the chief requisite of parts which are to be subjected to battering.

For most applications, then, hardness, toughness, wear resistance and resistance to heat softening are the prime selection factors in choosing tool steels.

In other cases, there are processing characteristics to be considered. Factors which fall in this category include the amount of distortion which is permissible in the shape under consideration; the amount of surface decarburization which can be tolerated; the depth of hardness which can be attained; the resistance to heat checking of the materials; and finally, the machinability.

A final class of consideration is the requirement as far as heat treating equipment and atmospheres are concerned.

What Steels for What Properties

Wear Resistance—All of the tool steels have relatively good wear resistance, but certain of them are outstanding in that property. Wear re-

sistance is defined as the ability to withstand wear or prevent the loss of dimensional tolerances. The property might be required over the total surface of the part or on a single cutting edge.

As a group the cold work tool steels have the best wear resisting properties, particularly those of the high carbon, high chromium types. Also, some of the special purpose tool steels are excellent in this property. This property is the least outstanding in the shock resisting steels and the less highly alloyed hot work steels.

Toughness—Toughness and shock resistance are pretty much the same in tool steels and result from a particularly strong core in the steels. As might be expected, this property is best in those steels with exceptionally low carbon contents which form the basis of the shock resisting tool steels. Most of the tool steels are good in this property except the cold work tool steels, which are high in carbon and, therefore, tend toward brittleness and hardness.

Dimensional Properties — Most steels tend to expand or contract, or both, when heated for forging or hardening, and many, depending upon their design, will deform due to warpage in quenching. Tool steels are no exception, save for the fact that some of them can be heated with much greater safety than others. Many which tend to change size during heating will revert almost to their original sizes upon subsequent drawing.

The extent to which sizes change is important on complex shapes, for it might be difficult to grind the part to final dimensions following the final hardening operation. Likewise, if parts involve rather drastic section changes, it would be unwise to make them of steels which are subject to excessive warpage in heating, as this could cause cracking and ruin the pieces.

As a general rule, the tool steels that are quenched in the least hard media are the best actors in heating and heat treating. In other words, the air quenching steels behave best during heating; those which are quenched in oil have moderately good properties, and the water hardening tool steels cause the most trouble in heating.

Resistance to Decarburization — Unless considerable care is taken in heating tool steels, such as packing in cast iron borings or other carbon containing materials or by using protective atmospheres, they are likely to lose some of their surface carbon and thus have a soft rather than a hard surface. Decarburization usually occurs when the steels are heated above 1300 F. Whether or not decarburization will occur readily is of extreme importance when the tools or parts involved are intricate in design and cannot be ground after hardening.

The straight carbon tool steels are least subject to decarburization. The majority of the other classes of tool steels are relatively good in this respect, with the exception of the hot work tool steels, which are considered to be only fair, and the shock resisting tool steels, most of which are highly susceptible to decarburization.

Keen Cutting Edges—For some applications, it is desirable that the tool steel have the ability to develop a fine, sharp cutting edge. The carbon and special purpose finishing tool steels form edges nicely, but are apt to lose them rapidly in some types of service. The high carbon, high chromium tool steels form a keen edge, but lose the extreme keenness fast. They retain a semi-keen edge for a long time.

Machinability — Machinability, of course, is the ability of the material to be cut freely and produce a good finish after being machined. As a basis of comparison, the 1% straight carbon tool steels have been given a machinability rating of 100. Most of the other tool steels rate as fair to good in machinability, with the exception of the more highly alloyed cold work steels, which are difficult to machine.

Red Hardness — Another important requisite in tool steels to be used for certain applications is their ability to retain hardness at high temperatures. This property is com-

Special shock resisting tool steels are used for making such products as chipping tools and other equipment subject to repeated impact, like the pneumatic chipping tool shown.

monly called red hardness. The high-speed steels and the hot work tool steels are best in this property, while the straight carbon and the low alloy tool steels are poorest. A tool steel with good red hardness is a must when temperatures at which the tools must operate exceed 900 F.

The properties enumerated are the most important ones to be considered when picking a tool steel, but there are others which must be kept in mind in other cases. For example, in die casting dies and plastics molds, a steel should be used which is resistant to the washing action of hot materials. Washing is the wearing away of the metal or some of its components by the combined action of heat and abrasion. Other properties to be watched for include high compressive strength and resistance to heat checking. The latter property prevents cracks from developing in the surface of the steel when its working cycle involves frequent heating and cooling.

Thus, from a study of the chief requirements of the tool, it is relatively easy to choose a tool steel that will serve adequately. As has been indicated, it is usually best to start with a straight carbon tool steel unless there are certain requirements, known at the outset, that can only be met with a more highly alloyed steel.

Forging dies are subjected to several destructive influences, and so must be made from particularly good tool steels. Tough, hot work tool steels are usually selected. Often two types of tool steels are used, one for the bulk of the die and a second for inserts which bear the brunt of the heat, impact and wear.

Heating and Heat Treatment of Tool Steels

All tool steels at some time during their processing must be subject to one or more heating operations, taking the nature of heating for forging, annealing or hardening and tempering. How a tool steel is heated has much to do with how it will perform in service, and improper heating anywhere along the line can undo all the work that has gone into a tool or part made from tool steel.

There are several general points to keep in mind in heating tool steels before we get into the specific heating and quenching operations.

For example, one of the most important requirements in heating tool steels is that they be kept at the desired temperature for the process for a sufficiently long period of time to make certain that the entire section has been heated uniformly. This holding period is generally referred to as soaking. There are various rules of thumb to cover the matter of soaking, but all agree that parts should be held at temperatures for a minimum of 1 hr for each inch of section thickness. In the case of some types of steel, the soaking period recommended might be as high as 4 hr per inch of temperature.

High carbon steels perform differently than some of the other tool steels in heating. For example, they take longer to heat than most of the other steels. Also, they are more prone to excessive decarburization when heated to hardening temperatures.

Sudden great changes in temperature of tool steels can cause cracking; therefore, it is usually good practice to preheat the steels before putting them in a furnace which has been warmed to high heat. Preheating also helps to reduce the time required for the part to be kept at temperature. In addition to avoiding or reducing cracking and warpage, pre-heating also helps to reduce excessive scaling, decarburization and excessive grain growth.

Some treaters of tool steels prefer placing the tool steel parts into cold furnaces and then bringing both the work and the furnace up to temperature at the same time.

Molten lead or salt baths are coming into increasing use for both heating and quenching, and are generally conceded to be much faster in heating than most other types of heating equipment. Many claim that parts placed in salts for heating can be brought up to temperature in about one-half the usual time. The salts also protect the steel against scaling, and, if properly rectified, against decarburization.

There are many reasons why a tool steel should not be heated too high or kept at heat too long. Some of the consequences of overheating are cracking, burning and excessive decarburization. Cracking, as indicated previously, results from heating too rapidly or not uniformly, and quenching from excessive temperatures has the same result. When overheated, steel might become burnt, which could, if carried on sufficiently long, result in the part falling apart. Overheating causes excessive grain growth in the steel and thereby causes a loss in strength and cohesion. The high carbon steels are most susceptible to overheating and burning.

Excessive decarburization results when tool steels are heated to a point above the scaling temperature in an ordinary furnace, and increases with extended times. Likewise, the tendency towards decarburization is greatest in high carbon steels where carbon migration is greatest. Decarburization can be controlled by packing the parts during heating or by heating them in reducing atmospheres. Decarburized areas must be removed from tool steel surfaces to provide satisfactory hardnesses.

Quenching for hardening and the subsequent tempering are important steps in treating tool steels and must be watched carefully to assure quality results. Most experts insist that tool steels should never be permitted to cool down to room temperature in the quench, but should be transferred to the draw furnace when between 100 and 200 F. The reason for this is that quenching sets up terrific strains in the work piece, which could cause cracking unless the steel is reheated to relieve these strains.

Small and intricate pieces are usually quenched from the low side of the hardening temperature while pieces of large section are heated to the top side of the hardening range and then annealed.

Heating for Forging

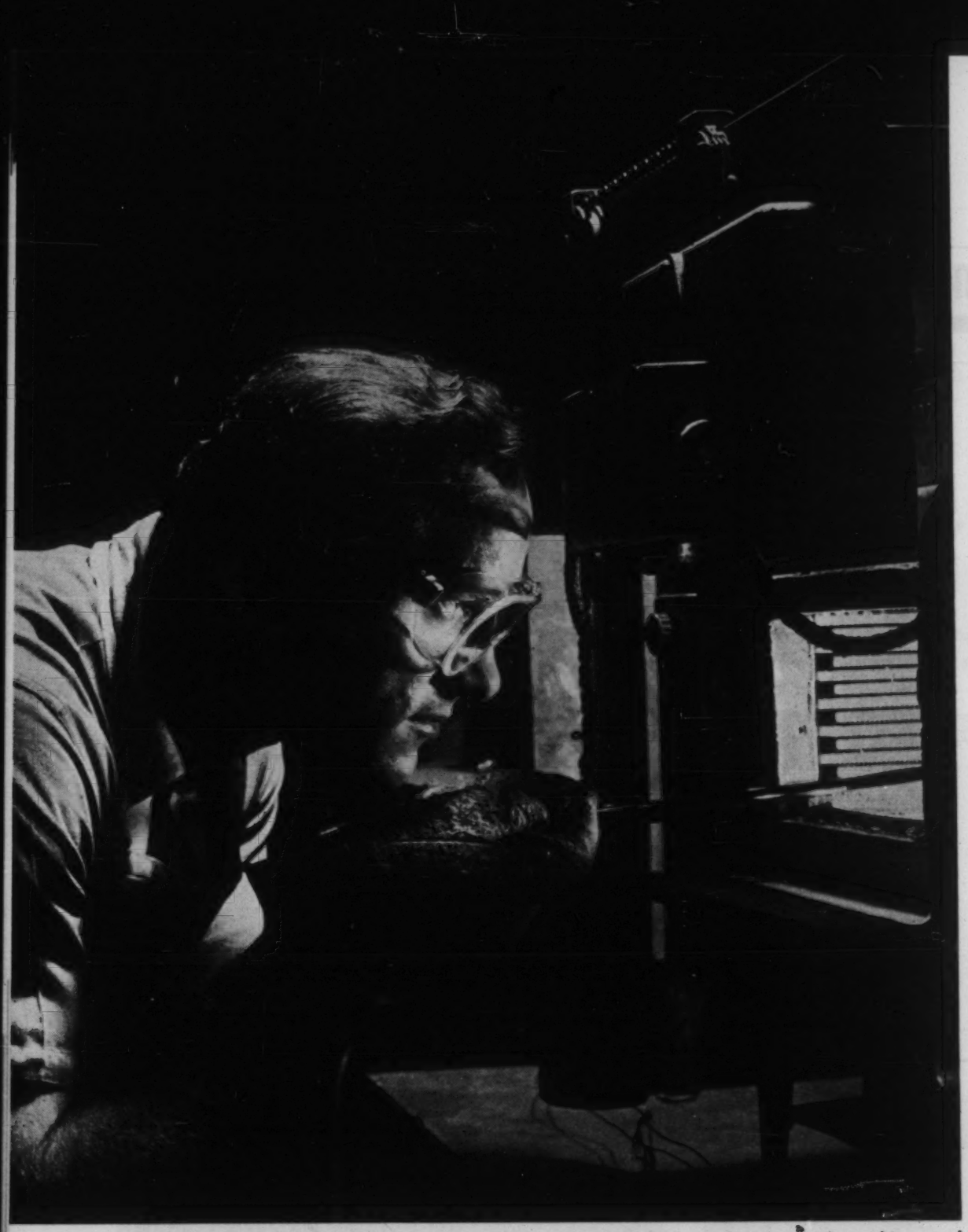
Many parts made from tool steels are shaped by forging. Steels to be forged should be heated slowly and, in most cases, a preheat is recommended. The steels should be held at temperature sufficiently long to insure uniform heat throughout the piece to make the entire metal volume plastic. High alloys usually require about twice as long to be heated uniformly throughout as do the carbon steels. Decarburization can be reduced in heating for forging by heating in a reducing atmosphere or by using less than the normal volume of air in the fuel mixture. Both the initial forging temperatures as recommended by the tool steel producers and the finishing temperatures, below which the steels should not be forged, must be watched carefully to avoid damaging the steel and to attain a sound distribution of fibers. Forging on high-carbon, high-chromium and high-speed tool steels should stop when temperatures fall to between 1600 and 1700 F; lower alloy types can be forged until the temperatures drop to between 1400 and 1500 F.

After forging, the parts should be cooled slowly and uniformly. Such cooling is best done by burying the parts in dry ashes, lime or similar materials, making certain that no moisture or air current reaches them.

Normalizing—Certain tool steels, primarily the straight carbon and low alloy tool steels, must be normalized after forging to refine the steel's grain structure and relieve forging strains. To normalize, the steel is heated to well above the critical temperature and then allowed to cool slowly in still air. Heavy sections of low alloy tool steel are heated to between 1550 and 1600 F. Normalizing should always be followed by an anneal.

Annealing

With tool steels, annealing is used to soften the metal for subsequent machining or forming and for grain refinement. Tool steel as pur-



Extreme care must be taken in the heat treating of tool steels to avoid cracking and decarburization as well as to attain the proper physical properties.

chased from the mill is usually in the fully annealed condition and does not require an additional anneal unless it has been forged or re-hardened.

Annealing is accomplished by heating the steel to slightly above the critical temperature and then slowly cooling. Much annealing is done by packing the parts in a container to prevent the formation of excessive scale and to avoid excessive decarburization. Packing is done by burying the piece in a tight container in the midst of cast iron chips, lime, mica or other neutral material in such a way that the part does not touch the container.

While packed, the container and the part are heated slowly up to the desired annealing temperature, held at the temperature for several hours, depending upon the size of the part, and then allowed to cool slowly while still in the furnace. Cooling should be at the rate of about 50 F per hr down to below 1000 F. High-speed steels are heated to about 1600 to 1650 F for annealing.

Strain relieving, sometimes known as subcritical annealing, is often employed where heavy machining, cold hubbing or other cold working has been done on the tool steel. Subcritical annealing requires that the work be heated to between 1100 and 1300 F, often in an open fire, and then cooled slowly. In some cases, where warpage is to be held to a minimum, it is the practice to rough machine the piece, then give it a strain relieving treatment, and then finish machine.

Hardening

Hardening must be employed with tool steels to develop maximum physical properties, including tensile and compressive strength and wear resistance. Hardening consists of heating the tool steel to its hardening temperature and then rapidly cooling in the proper quenching medium, such as water, brine, oil and air. For heating, molten baths are fastest, semi-muffle furnace next, and electric and full-muffle furnaces slowest.

Heating for hardening must be done slowly and uniformly to avoid warpage. The heating rate is slower for the high alloy steels than for straight carbon and low alloy steels. It is often advisable to preheat the tool steel slowly in one furnace and then transfer the piece to another furnace held at the proper hardening temperature. With some types of steel, chiefly high-speed steels, the preheat procedure is necessary.

Carbon and Low Alloy Steels—With these steels, unless a preheat is employed, charging into the furnace should never be done when furnace temperatures are above 1000 F. Parts should be kept at heat in a slightly oxidizing atmosphere. If hardening is not done in a furnace where protective atmospheres are practicable, the parts should be heated in a molten bath or packed in a carbonaceous material to prevent decarburization.

High Alloy Tool Steels—With high alloy tool steels, slow heating is imperative to allow the proper solution of carbides. Usually the steels are preheated to about 1200 F and then transferred to a hardening furnace. Pack hardening is often employed. With the high chromium types of tool steels, even longer heating times are required than for the other high alloy materials.

High-Speed Steels—With the exception of extremely small pieces, all high-speed steel parts must be preheated at 1500 to 1600 F before being placed in the hardening furnace. When very large pieces are involved, two-stage preheating is advisable—the first at 1000 to 1200 F and the second at 1500 to 1600 F. The hardening furnace should always be at high heat and be sufficiently large so that no great temperature drop occurs when the piece to be hardened is placed in it. A reducing atmosphere is used in the furnace.

Care must be taken that too long a soaking period is not allowed for high-speed steels, but usually 1 hr

per in. of section thickness is quite satisfactory. Tools must be properly supported to avoid sagging at high heat. Parts that are to be subject to shock are best heated at the lower hardening range.

Quenching

The manner and media of quenching varies according to the steel being quenched and the speed required in quenching. Usually large volumes of the quenching medium are provided so as to keep the bath within desired temperature limits. The usual quenching media are water, brine, oil and air.

Water (including brine) is the most drastic of the quenching materials, oils are somewhat less drastic, and air is the mildest quenching medium. It is desirable to cool tool steels as rapidly as possible in quenching, but it is not recommended that quenching fluids be agitated by air.

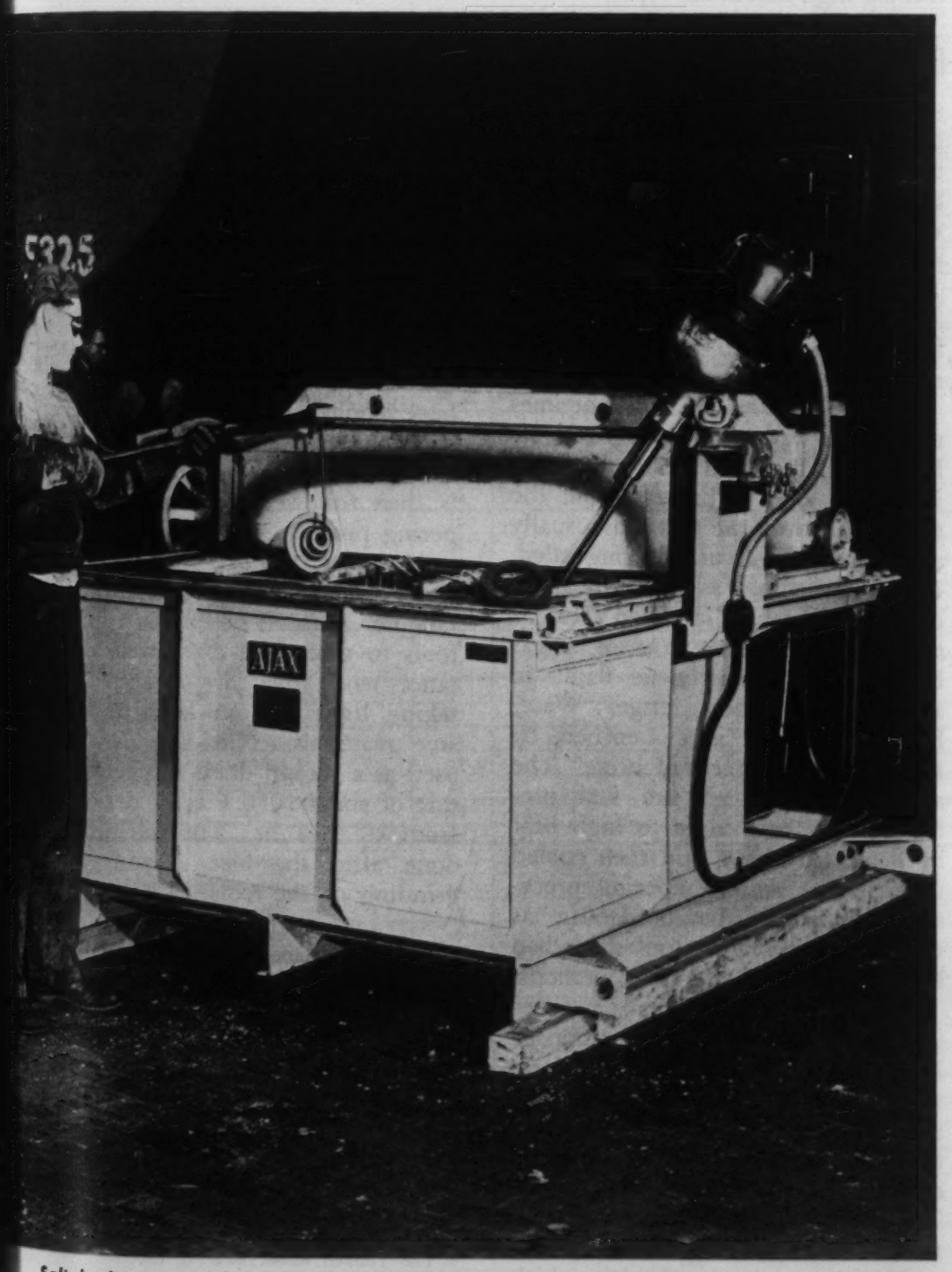
Brine, water with 10% by weight of salt, is a more uniform and more drastic quench than water in still or mildly agitated baths. Because of the drastic nature of waters and brines, parts are usually removed from the quench when they have been cooled to about 200 F to prevent further strains from developing. There is the least size change and warpage in parts when quenched in air, but only the most highly alloyed steels can be so quenched. Molten salt or lead quenching is midway between oil and air as to the drastic action on parts being quenched, but salt bath quenching is often used instead of air quenching.

Carbon and Low Alloy Steels—Brine or water are used to quench steels of the straight carbon and low alloy types. Brine has the advantage of creating less adhering scale on tool steels than water. Either quenching medium should be used at temperatures between 60 and 70 F. Sprays or geysers are often used to develop greater hardness penetration. When the alloy content becomes higher, an oil quench is used.

High Alloy Tool Steels—Oil and air are used in quenching the more highly alloy tool steels, with the oil being used on the low end of the alloy scale. In air cooling, still air, fan cooling and compressed air blasts are used, but still air is the preferred method, for it is more likely to provide uniform cooling. When compressed air is used, extreme care must be taken to provide moisture-free air.

High-Speed Steels—Oil, air and molten baths are used to quench the high-speed tool steels. Some, particularly the molybdenum high-speed steels, are quenched down to 150 F in oil and then air cooled. Others are cooled to just below red heat in oil and then cooled completely in air. Air current cooling is employed where toughness is essential. Recently interrupted quenching has been used more extensively on tool steels. By this method, the steels are cooled to between 900 and 1200 F in a molten bath of salt or lead, then cooled in air to about 150 F and immediately tempered.

Tempering—Tools and parts made of tool steels should be placed in the tempering furnace before they have cooled to room temperature after quenching so as to minimize the danger of cracking from strains imposed by quenching. Tempering, or drawing as it is frequently called, consists of reheating the steels to comparatively low temperatures and then cooling them slowly. The tempering operation releases the strains developed during hardening and reduces somewhat the hardness developed during hardening so as to provide more toughness in the tool steel parts. The preferred practice is to give tool steel parts long draws at comparatively low temperatures rather than short draws at high



Salt baths are used extensively in hardening and annealing tool steels, particularly the high-speed steels. Salt baths provide quick heat exchange and close temperature control.

temperatures.

Carbon and Low Alloy Steels—The straight carbon steels are usually tempered at temperatures between 300 and 400 F and those containing moderate amounts of alloying elements between 300 and 500 F. Because there is a drop in toughness over 500 F, tempering between 500 and 900 F is not recommended. Tempering should be done in furnaces in which temperatures can be accurately controlled or in oil or salt baths. In tempering, it is important that the parts being tempered do not touch the furnace or the pots in which the molten baths are contained.

Tools should be warm when they are placed in the tempering furnace or bath and then heated slowly up to temperature and finally allowed to soak for a minimum of 1 hr per inch of section thickness. Cooling in still air is recommended.

High Alloy Tool Steels—Tool steels with high alloy contents are tempered at much higher temperatures than the carbon and low alloy steels. Temperatures range up to between 900 and 1300 F for the high-carbon, high-chromium steels. For most alloy steels the temperature range of 300 to 500 F is used for hardness and 900 to 1000 F for toughness.

High-Speed Steels—The high-speed steels are tempered in the temperature range of 950 to 1100 F, and in the case of these steels it is imperative that tempering start as soon after quenching as is possible. If a salt bath temper is to be used, it is suggested that the steels be preheated to 500 F before they are placed in the salt bath. The high-speed steels are also cooled in still air. Many treaters of high-speed steels prefer a double draw, which merely repeats the original cycle.

Atmospheres

Atmospheres for heating tool steels, particularly when heats approach or reach the critical temperatures, are essential unless the parts are packed to protect the surfaces or heated in molten baths. Atmospheres used are oxidizing, neutral or reducing, depending upon the steels being heated and upon the circulatory system of the furnace being used.

When fuel-fired furnaces are used, the atmosphere is controlled by the air-fuel ratio. A surplus of air above the amount required to support full combustion results in an oxidizing atmosphere; less air than required for complete combustion makes the atmosphere reducing; and a neutral atmosphere is when the air and fuel ratios are in balance.

Electric and completely muffled furnaces require prepared atmospheres from an outside generator when conditions demand special atmospheres.

Low temperature hardening—under 1600 F of the straight carbon and low manganese oil hardening steels—requires a temperature that is slightly oxidizing. Treatments over 1600 F usually call for a slightly reducing atmosphere to keep scaling to a minimum and still prevent decarburization. Alloys in the latter group include the hot work steels, high-speed steels and the high-carbon, high-chromium types.

Other Thermal Treatments

There are several other thermal treatments or methods of heating tool steels that are used from time to time. Most of them are not widely used, but do serve under certain specific circumstances and with some of the tool steels. None are widely used because of the limitations, which are explained. The methods follow:

Flame Hardening is sometimes used with water hardening and air hardening tool steels, but its use is limited due to the fact that the temperatures of the methods usually used cannot be accurately controlled. Flame hardening, as generally used, consists of heating localized areas of the tool steels by means of a gas burner or an oxacetylene flame to above the hardness range. Water hardening steels are quenched by flushing with water and brine. The air hardening steels are first preheated and then raised to high heat by flame hardening and then cooled in air. The same tempering procedures follow flame hardening as would be used if the tool steels had been hardened by the usual methods.

Induction Hardening is sometimes used to selectively harden carbon or low alloy tool steel parts, particularly when moderate to large quantities of similar parts are involved. Induction hardening is not generally used on high-speed and alloy tool steels. The usual tempering procedures are followed.

Martempering, a method in which tool steel parts are quenched in a molten bath down to about 400 F, is sometimes used with manganese oil hardening and some of the shock resisting tool steels of intricate shape and small sections. The martempering process, being less harsh than water or oil quenching, does not impose strains to the same extent as other quenching methods. Parts are quenched from the hardening temperatures, held long enough for the temperatures to equalize, and are then air cooled.

Austempering is similar to martempering except that quenching is only down to between 450 and 800 F. The process is used to allow a transformation from austenite to a nonmartensitic structure in the metal. Here again, the process is usually restricted to the carbon and low alloy tool steels in thin and comparatively small sections where the chief requisites of the parts are toughness and fatigue resistance. Austempering is not generally used on tool steels because of the relatively low hardness developed.

Sub-Zero Treatments are sometimes employed to complete the transformation from austentite to martensite, particularly in the high-carbon, high-chromium and 5% chromium tool steels. The treatment is carried out immediately after quenching when the tools or parts have cooled to room temperature, and consists of treating the steels at −100 to 120 F. The cold treatment is then followed by the usual tempering process.

Nitriding, a process in which the steels are treated in sodium and potassium salts, is used on cutting tools to give them extra wear resistance when they are intended for taking light cuts on hard or abrasive materials. Nitriding is often used as a second draw at a temperature of about 1050 F for a period of from ½ to 1 hr. The nitriding is done after the first drawing and grinding of the tools.

Acknowledgments

The author wishes to acknowledge, with appreciation, the assistance of the following firms in the preparation of this Manual:

Allegheny Ludlum Steel Corp.
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General Motors Co.
Latrobe Steel Co.
The Timken Roller Bearing Co.
Vanadium Alloys Steel Co.

Materials Engineering File Facts

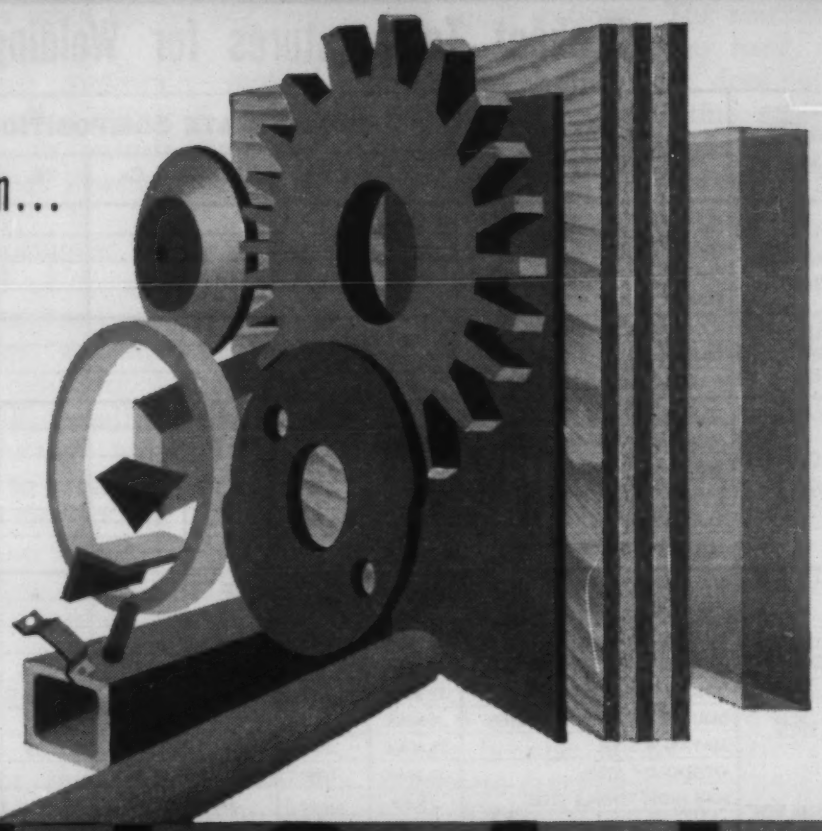
MATERIALS & METHODS
August - 1952
Number 232

Preheat Temperatures for Welding Metals and Alloys

METAL GROUP	METAL DESIGNATION	APPROXIMATE COMPOSITION — PERCENT								METAL DESIGNATION	RECOMMENDED PREHEAT
		C.	Mn.	Si.	Cr.	Ni.	Mo.	Cu.			
PLAIN CARBON STEELS	PLAIN CARBON STEEL	BELOW .20								PLAIN CARBON STEEL	UP TO 200°F
	PLAIN CARBON STEEL	.20-.30								PLAIN CARBON STEEL	200°F-300°F
	PLAIN CARBON STEEL	.30-.45								PLAIN CARBON STEEL	300°F-500°F
	PLAIN CARBON STEEL	.45-.80								PLAIN CARBON STEEL	500°F-800°F
CARBON MOLY STEELS	CARBON MOLY STEEL	.10-.20					.50			CARBON MOLY STEEL	300°F-500°F
	CARBON MOLY STEEL	.20-.30					.50			CARBON MOLY STEEL	400°F-600°F
	CARBON MOLY STEEL	.30-.35					.50			CARBON MOLY STEEL	500°F-800°F
MANGANESE STEELS	SILICON STRUCTURAL STEEL	.35	.80	.25						SILICON STRUCTURAL STEEL	300°F-500°F
	MEDIUM MANGANESE STEEL	.20-.25	1.0-1.75							MEDIUM MANGANESE STEEL	300°F-500°F
	SAE T 1330 STEEL	.30	1.75							SAE T 1330 STEEL	400°F-600°F
	SAE T 1340 STEEL	.40	1.75							SAE T 1340 STEEL	500°F-800°F
	SAE T 1350 STEEL	.50	1.75							SAE T 1350 STEEL	600°F-900°F
	12% MANGANESE STEEL	1.25	12.0							12% MANGANESE STEEL	USUALLY NOT REQUIRED
HIGH TENSILE STEELS (SEE ALSO STEELS BELOW)	MANGANESE MOLY STEEL	.20	1.65	.20			.35			MANGANESE MOLY STEEL	300°F-500°F
	JALTEN STEEL	.35 MAX.	1.50	.30				.40		JALTEN STEEL	400°F-600°F
	MANTEN STEEL	.30 MAX.	1.35	.30				.20		MANTEN STEEL	400°F-600°F
	ARMCO HIGH TENSILE STEEL	.12 MAX				.50 MIN.	.05 MIN.	.35 MIN.		ARMCO HIGH TENSILE STEEL	UP TO 200°F
	DOUBLE STRENGTH #1 STEEL	.12 MAX.	.75			.50-1.25	.10 MIN.	.50-1.50		DOUBLE STRENGTH #1 STEEL	300°F-600°F
	DOUBLE STRENGTH #1A STEEL	.30 MAX.	.75			.50-1.25	.10 MIN.	.50-1.50		DOUBLE STRENGTH #1A STEEL	400°F-700°F
	MAYARI R STEEL	.12 MAX.	.75	.35	.2-1.0	.25-.75		.60		MAYARI R STEEL	UP TO 300°F
	OTISCOLOY STEEL	.12 MAX.	1.25	.10 MAX.	.10 MAX.			.50 MAX.		OTISCOLOY STEEL	200°F-400°F
	NAX HIGH TENSILE STEEL	.15-.25		.75	.60	.17	.15 MAX.	.25 MAX.	Zr. .12	NAX HIGH TENSILE STEEL	UP TO 300°F
	CROMANSIL STEEL	.14 MAX.	1.25	.75	.50					CROMANSIL STEEL	300°F-400°F
	A. W. DYN-EL STEEL	.11-.14						.40		A. W. DYN-EL STEEL	UP TO 300°F
	CORTEN STEEL	.12 MAX.		.25-1.0	.5-1.5	.55 MAX.		.40		CORTEN STEEL	200°F-400°F
	CHROME COPPER NICKEL STEEL	.12 MAX.	.75		.75	.75		.55		CHROME COPPER NICKEL STEEL	200°F-400°F
	CHROME MANGANESE STEEL	.40	.90		.40					CHROME MANGANESE STEEL	400°F-600°F
	YOLOY STEEL	.05-.35	.3-1.0			1.75		1.0		YOLOY STEEL	200°F-600°F
	HI-STEEL	.12 MAX.	.6	.3 MAX.		.55		.9-1.25		HI-STEEL	200°F-500°F
NICKEL STEELS	SAE 2015 STEEL	.10-.20				.50				SAE 2015 STEEL	UP TO 300°F
	SAE 2115 STEEL	.10-.20				1.50				SAE 2115 STEEL	200°F-300°F
	2½% NICKEL STEEL	.10-.20				2.50				2½% NICKEL STEEL	200°F-400°F
	SAE 2315 STEEL	.15				3.50				SAE 2315 STEEL	200°F-500°F
	SAE 2320 STEEL	.20				3.50				SAE 2320 STEEL	200°F-500°F
	SAE 2330 STEEL	.30				3.50				SAE 2330 STEEL	300°F-600°F
	SAE 2340 STEEL	.40				3.50				SAE 2340 STEEL	400°F-700°F
MEDIUM NICKEL CHROMIUM STEELS	SAE 3115 STEEL	.15			.60	1.25				SAE 3115 STEEL	200°F-400°F
	SAE 3125 STEEL	.25			.60	1.25				SAE 3125 STEEL	300°F-500°F
	SAE 3130 STEEL	.30			.60	1.25				SAE 3130 STEEL	400°F-700°F
	SAE 3140 STEEL	.40			.60	1.25				SAE 3140 STEEL	500°F-800°F
	SAE 3150 STEEL	.50			.60	1.25				SAE 3150 STEEL	600°F-900°F
	SAE 3215 STEEL	.15			1.00	1.75				SAE 3215 STEEL	300°F-500°F
	SAE 3230 STEEL	.30			1.00	1.75				SAE 3230 STEEL	500°F-700°F
	SAE 3240 STEEL	.40			1.00	1.75				SAE 3240 STEEL	700°F-1000°F
	SAE 3250 STEEL	.50			1.00	1.75				SAE 3250 STEEL	900°F-1100°F
	SAE 3315 STEEL	.15			1.50	3.50				SAE 3315 STEEL	500°F-700°F
	SAE 3325 STEEL	.25			1.50	3.50				SAE 3325 STEEL	900°F-1100°F
	SAE 3435 STEEL	.35			.75	3.00				SAE 3435 STEEL	900°F-1100°F
	SAE 3450 STEEL	.50			.75	3.00				SAE 3450 STEEL	900°F-1100°F
MOLY BEARING CHROMIUM AND CHROMIUM NICKEL STEELS	SAE 4140 STEEL	.40			.95		.20			SAE 4140 STEEL	600°F-800°F
	SAE 4340 STEEL	.40			.65	1.75	.35			SAE 4340 STEEL	700°F-900°F
	SAE 4615 STEEL	.15				1.80	.25			SAE 4615 STEEL	400°F-600°F
	SAE 4630 STEEL	.30				1.80	.25			SAE 4630 STEEL	500°F-700°F
	SAE 4640 STEEL	.40				1.80	.25			SAE 4640 STEEL	600°F-800°F
	SAE 4820 STEEL	.20				3.50	.25			SAE 4820 STEEL	600°F-800°F
LOW CHROME MOLY STEELS	2% Cr.-½% Mo. STEEL	UP TO .15			2.0		0.5			2% Cr.-½% Mo. STEEL	400°F-600°F
	2% Cr.-½% Mo. STEEL	.15-.25			2.0		0.5			2% Cr.-½% Mo. STEEL	500°F-800°F
	2% Cr.-1% Mo. STEEL	UP TO .15			2.0		1.0			2% Cr. 1% Mo. STEEL	500°F-700°F
	2% Cr.-1% Mo. STEEL	.15-.25			2.0		1.0			2% Cr. 1% Mo. STEEL	600°F-800°F
MEDIUM CHROME MOLY STEELS	5% Cr.-½% Mo. STEEL	UP TO .15			5.0		0.5			5% Cr.-½% Mo. STEEL	500°F-800°F
	5% Cr.-½% Mo. STEEL	.15-.25			5.0		0.5			5% Cr.-½% Mo. STEEL	600°F-900°F
	8% Cr.-1% Mo. STEEL	.15 MAX.			8.0		1.0			8% Cr.-1% Mo. STEEL	600°F-900°F
PLAIN HIGH CHROMIUM STEELS	12-14% Cr. TYPE 410	.10			13.0					12-14% Cr. TYPE 410	300°F-500°F
	16-18% Cr. TYPE 430	.10			17.0					16-18% Cr. TYPE 430	300°F-500°F
	23-30% Cr. TYPE 446	.10			26.0					23-30% Cr. TYPE 446	300°F-500°F
HIGH CHROME NICKEL STAINLESS STEELS	18% Cr. 8% Ni. TYPE 304	.07			18.0	8.0				18% Cr. 8% Ni. TYPE 304	USUALLY DO NOT REQUIRE PREHEAT BUT IT MAY BE DESIRABLE TO REMOVE CHILL
	25-12 TYPE 309	.07			25.0	12.0				25-12 TYPE 309	
	25-20 TYPE 310	.10			25.0	20.0				25-20 TYPE 310	
	18-8 Cb. TYPE 347	.07			18.0	8.0			Cb. 10XC	18-8 Cb. TYPE 347	
	18-8 Mo. TYPE 316	.07			18.0	8.0	2.5			18-8 Mo. TYPE 316	
	18-8 Mo. TYPE 317	.07			18.0	8.0	3.5			18-8 Mo. TYPE 317	

Courtesy, Tempil Corp.

REICHHOLD



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Materials Engineering File Facts

MATERIALS & METHODS
August • 1952
Number 233

Forming, Polishing and Machining Magnesium

Formability

ALLOY	CONDITION	Approx Min 90 Bend Radius[1]			Max % Reduction per Draw[2]			Best Temp, F, for Hot Working ± 50 F	Approx Temp of Beginning Hot Shortness, F
		70 F	400 F	600 F	70 F	400 F	600 F		
M1	Annealed	5t	3t	2t	20	30	50	600	850
M1	Hard rolled	12t	5t	2t	...	...	...	400	850
M1	Extruded	...	...	...	...	...	...	600	850
AZ31	Annealed	4t	3t	2t	20	30	50	500	800
AZ31	Hard rolled	12t	4t	2t	...	...	...	350	800
AZ31	Extruded	...	...	...	...	...	...	500	800
AZ80	Extruded	...	...	...	...	...	...	500	750

Tube Bending Radius

ALLOYS	70 F	400 F	600 F
M1 AZ31 AZ80	Approximate minimum 90° bend radius to center of tube 4 X tube diameter	Approximate minimum 90° bend radius to center of tube 2 X tube diameter	Approximate minimum 90° bend radius to center of tube 1½ X tube diameter

Typical Procedures for Polishing

Operation	Abrasive	Type Wheel	Wheel Dia, In.	Wheel Speed, fpm	Remarks
Rough Polish	60 to 100	Canvas, sheepskin or felt	6 to 12	3000 to 5000	Required only for rough surfaces such as sand castings. Grease stick can be used.
Medium Polish	100 to 200	Built-up cloth	6 to 12	4000 to 6000	Grease stick can be used.
Dry Fine Polish	Dry compound	Loosely sewed buff	6 to 12	3500 to 5000	.....
Buffing	Tripoli	Loosely sewed buff 74 to 82 count cloth	10 to 14	6000 to 8000	.....
Coloring	Dry lime	Canton flannel buff	12 to 16	8000 to 12000	Minimum pressure to produce best luster.

Tool Materials for Machining

Carbon Tool Steels	Can be used for finishing tools, drills, taps, reamers.
High-Speed Steels	Preferred for finishing tools, all types of cutting tools, drills, taps, reamers.
Cemented Carbide	Should be used for high quantity production machining; give longer tool life and better operating economy at high speeds.
Cast Tungsten Cobalt	Can be used for high quantity production; tool life between that of high-speed steel and cemented carbides.

Recommended Properties of Coolants for Machining

Property	Value
Specific Gravity	0.79–0.86
Viscosity (Saybolt) at 100 F	Up to 55 sec
Flash Point—Min Value (Closed Cup)	300 F
Saponification No. (Max)	16
Free Acid (Max)	0.2%

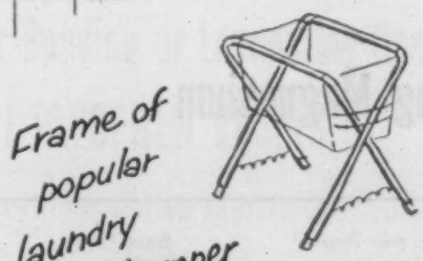
NOTES: [1] *Values for minimum bend radius apply to 0.040- to 0.072-in. thickness; values decrease for thinner gages and increase for thicker gages. Smaller bend radii can be successfully used when bends are with-grain rather than across-grain. Tube bend minimum radii will vary with diameter of tube and thickness of tube wall.*

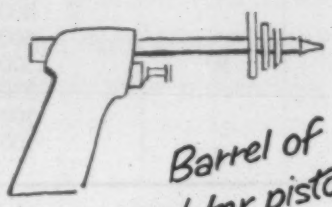
[2] $\text{Percent reduction} = \frac{\text{Blank Diameter} - \text{Punch Diameter} \times 100}{\text{Blank Diameter}}$

Courtesy of The Magazine of Magnesium.

Bundyweld "Doodles"

to jog a designer's imagination





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No other tubing has all the Bundyweld features. It's the only tubing double-walled from a single strip, with inside and outside beveled edges.

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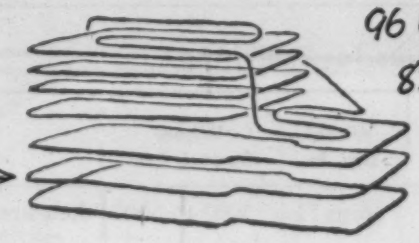
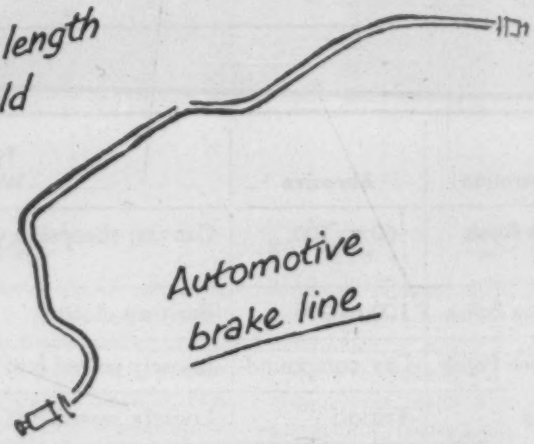




Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Extra-strong	Easily machined
High fatigue limit	Takes plating
Leakproof	Takes plastic coating
High bursting point	Scale-free
High thermal conductivity	Clean inside and out
Shock-resistant	No inside bead
Ductile	Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Presto . . . Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

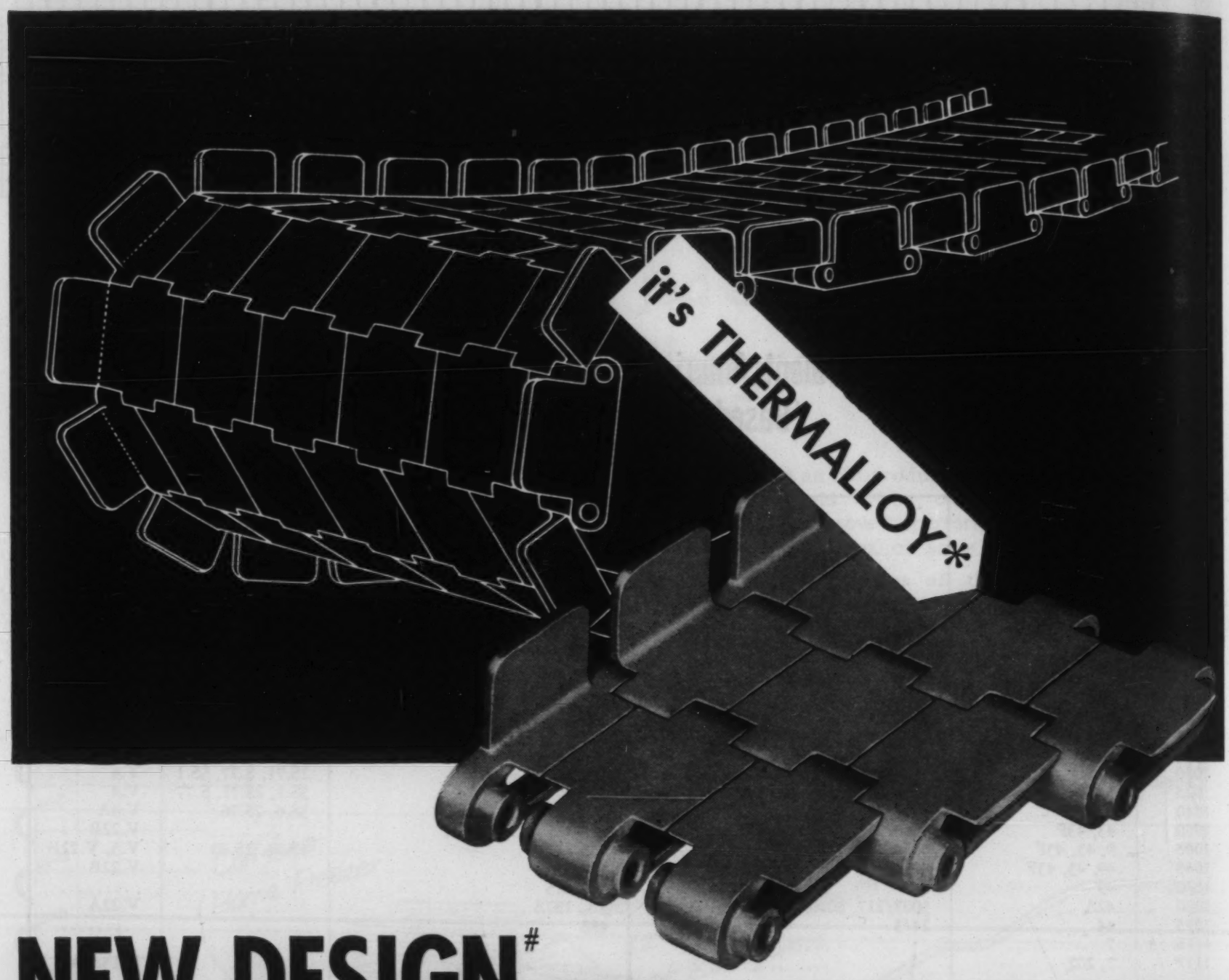
Bundy Tubing Distributors and Representatives: ***Cambridge, 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Approximately Equivalent American and British Steel Specifications (Based on Composition)

AISI and SAE	En	B. S.	D. T. D.	B. S. Aircraft, 1945	
				S.	S. T. A. 5
Carbon Steels					
1008	32A	5006/206, 5006/105, 5005/101	.....	3S.14	V.15/1
1010	32A	5006/206, 5006/105, 5005/101	.....	3S.14	V.15/1
1015	32B	5006/206, 5005/101, 5006/105	.....	3S.14	V.15
1016	32B	5006/206, 5005/101, 5006/105	.....	3S.14	V.15
1020	3, 3A	32/2, 401, 5004/201	563	S.3, 4S.21	V.3
1022	3, 3A, 3B	32/2, 401, 5004/201	563	S.3, 4S.21	V.3 (C.D.)
1025	4, 4A	.....	.....	2S.71	.....
1030	5, 5D, 6	5005/202, 32/1, 5006/205, 5007/216	398	2S.71, S.77, 5S.1	V.4
1035	5, 6	32/1, 5006/205, 5005/202, 5007/216	398	5S.1, 2S.71, S.77	V.4
1040	8	5005/203, 5009/212	.....	3S.6, 2S.76	V.4A
1050	43, 43F	5010/218	.....	.....	V.22B
1055	9, 43, 43F	46/4, 224/1, 5010/218	153	3S.24, 2S.70	V.5, V.22B
1060	49, 43, 43F	5010/218	5A, 215	.....	V.22B
1070	49	.....	5A, 215	.....	.....
1080	42A	5007/217, 5010/219	5A, 187A	.....	V.22A
1095	44	24/3	488	.....	.....
1115	7	.....	.....	.....	.....
1117	7, 202	.....	.....	.....	V.15A.M.
Alloy Steels					
1320	14A, 14B	305	124A, 126A	S.92	.....
1335	15, 15A	.....	501	S.93	V.7
2330	21, 51	5008/403, 5005/401	.....	.....	.....
2340	22	5005/402	.....	2S.2, S.69	.....
2515	37, 38	5005/104	.....	S.90	.....
3135	110, 111	.....	.....	2S.2, S.95	.....
4137	19, 19A, 19B, 19C	5005/601	167, 470	2S.2	V.9D
4140	19, 19A, 19B, 19C	5005/601	167, 470	2S.2	V.9D
4320	325	.....	.....	.....	.....
4615	34	.....	.....	.....	V.16A
4620	34, 35	.....	.....	.....	V.16A, V.16B
4640	111, 160, 161	.....	.....	2S.2	.....
5120	207	.....	.....	.....	.....
5140	18	5005/601	461	2S.2	V.9C
5150	11	681, 5010/603	.....	.....	.....
52100	31	.....	.....	.....	V.14
6150	47	5010/605	.....	.....	.....
9255	45	5010/801	115	.....	.....
9260	45	5010/801	115	.....	.....
Stainless Steels					
410	56A	.....	53, 97A, 102A, 161, 525	S.85, S.61	V.25B/1
420	56D	5008/602	271, 326, 463	5S.62	V.25A
430	57	.....	60B, 163A, 185A, 199, 301, 401	2S.80	V.28

NOTES: En—Steels developed to conserve alloying elements for the same reasons that the NE steels were developed.
B.S.—British Standard.
D.T.D.—Department of Technical Development.
S.—Prefix attached to aircraft steels.
S.T.A.5—Superintendent Technical Applications.

Adapted by permission from "Steels in Modern Industry", edited by W. E. Benbow, and published by Iliffe & Sons, Ltd., London.



NEW DESIGN# means

GREATER STRENGTH • INCREASED LOAD CAPACITY

Note the "staggered" link arrangement in the new Thermalloy conveyor belt section illustrated above. It offers you special advantages in heat-treat applications.

First—this design of link eliminates "crank-shafting".

Second—the new design can carry a considerably heavier load, without increasing the amount of alloy used.

Third—the use of shorter, free-floating, "cast-in" pins, instead of large and rigid continuous wrought pins used in conventional designs, reduces bending stresses under heavy loads.

For full information on this improved Thermalloy conveyor design, contact your nearest Electro-Alloys representative. Or write Electro-Alloys Division, 2088 Taylor Street, Elyria, Ohio.

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AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

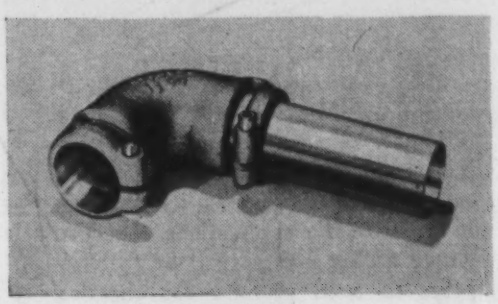
New Stainless Steel Coupling Reduces Assembly Costs

The Quikupl stainless steel fitting, a new coupling designed to reduce assembly costs and to permit the use of less expensive, lighter-wall stainless steel tubing, has been announced by *Peter A. Frasse and Co., Inc.*, 17 Grand St., New York 13, and The *Cooper Alloy Foundry Co.*, Hillside, N. J. Chief advantage claimed for the new fitting is that it can be joined to tube or pipe without threading, flaring, sweat-soldering, brazing or welding, saving the cost of these operations. With the new fitting, pipe or tube is simply cut to length, deburred and inserted in the fitting. The coupling is completed merely by tightening a small screw.

Because the need for threading is eliminated, users of stainless steel tube or pipe escape the extra cost of heavy walls formerly required to take threads for screwed fittings. Furthermore, where industrial concerns already have changed to lighter wall tubing, Quikupl fittings are said to materially reduce the high cost of flaring, fabrication or welding which ordinary tube fittings heretofore necessitated.

In design, the new fittings resemble standard elbows, tees, ells, and other universal shapes, with the addition of a clamp which is an integral part of the fitting. Pipe or tube is inserted into the fitting and only one tool—a simple hex wrench—is needed to tighten the clamp. Inside the fitting is a synthetic sealing ring which is contained in a groove machined into the bore of the Quikupl. This resilient seal is so constructed that it will provide and maintain a squeeze fit regardless of commercial tube and pipe tolerances. Design of the seal is such that pressure in the line, from either direction of flow, jams it into a positive fit and seals any space between the fittings and the tube or pipe.

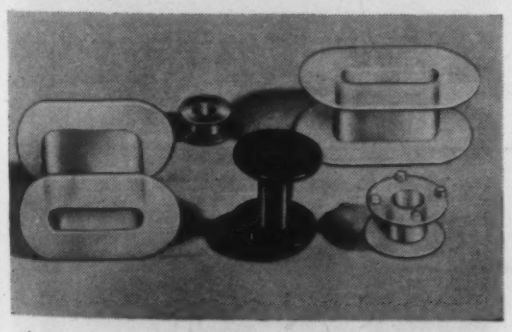
It is anticipated that the fittings will have widespread use in the chemical processing, textile processing, photographic and oil refining industries. It is also expected that numerous applications will be made in the food, drug, paper and pulp, refrigeration, power generation and marine fields.



This stainless steel fitting can be joined to tube or pipe without threading, flaring, sweat-soldering, brazing or welding.

Cooper Alloy is manufacturing the fittings in tees, couplings, ells (45 and 90 deg) and adapters in Types 304 and 316 stainless. Other types are expected to be added to meet demand. For use at temperatures up to 275 F, depending on corrosive agent involved, the fittings are in the 150-psi class.

Molding Technique Produces Improved Coil Bobbins



An economical, high-speed, single cavity injection molding process is achieving more accurate and uniform results in the production of these nylon coil bobbins.

An exclusive and economical high-speed, single cavity injection molding process is currently offered by *Gries Reproducer Corp.*, 793 E. 132nd St., New York 54, which is said to achieve more uniform and accurate results in the volume production of nylon coil bobbins. The method is completely automatic. Special patented molding machines run continuously without manual control and do not require an operator. This automatic control, plus a high-speed cycle which delivers a finished degated part for each cycle, assures competitive prices on an improved product.

Single cavity operation permits low initial mold and mold maintenance costs. The company's coil bobbins are available at the maximum weight of 0.025 oz, not longer than 1 in. Smallness, however, is unlimited. The bobbins can be supplied in other thermoplastics as well as nylon.

Brazing Alloy for Brazing Chromium Carbide, Cast Carbides

Handy & Harman, 82 Fulton St., New York 38, has announced the development of a new metal joining composition known as EB silver brazing alloy, which is primarily intended for use in brazing chromium carbide, cast carbides and other "hard-to-wet" carbides. Effective results have also been obtained on high tungsten-copper alloy, cermets and other refractory alloys difficult to braze.

The new alloy is composed of 57% silver, the balance of the composition including copper, manganese and tin. It has a melting point of 1120 F and a flow point of 1345 F.

There are no volatile elements in this alloy, an important factor in vacuum applications, and it is nonsusceptible to dezincification type of corrosion. According to the company, it has been successfully used on Type 316 stainless steel subject to dilute mineral acid corrosion. This does not, however, imply a general recommendation for corrosive service, but does indicate a quality which may prove useful when evaluated by tests under actual service conditions.

Thermosetting Laminate Combines High Arc Resistance with Good Mechanical and Chemical Properties

A new grade of thermosetting laminate, which is said to combine high arc resistance with good mechanical and chemical properties, has been developed by *Synthane Corp.*, Oaks, Pa. Designated as G-8, the plastic presents a considerable saving in cost below that of the continuous filament glass base material (NEMA Grade G-5) whose electrical properties it appears to equal.

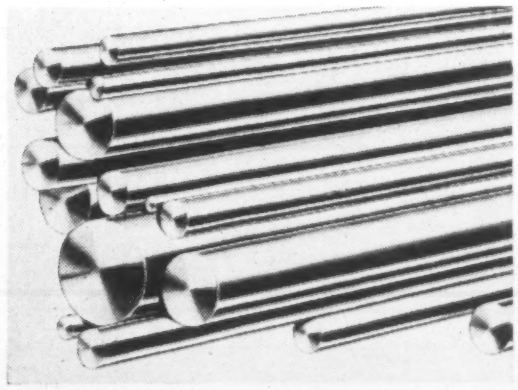
G-8 was developed in response to suggestion by the Navy, whose Bureau of Ships is currently using this grade in buss transfer switches for military applications. In addition to its obvious uses in electrical applications, particularly where arcing may occur, the material appears to hold promise for chemical resistant uses such as in the plating and photographic industries.

The new material, laminated in thicknesses from 1/16 in. upward, uses a glass fiber mat impregnated with melamine resins. Thus, its mechanical properties are less directional than those of a woven-base laminate. Also typical of mat-based laminates is its ability to machine readily to a smooth surface. Mainly, its lower production cost reflects the elimination of the weaving operation. Too, no lubricant has to be applied, and later removed, as is the case when glass fibers are woven.

Compared in Synthane laboratories with GLCC-M or G-5, the G-8 showed electrical properties approximately equal, mechanical strengths about two-thirds as great.

Average values obtained in this test program:

Flexural Strength, Psi	
Lengthwise	30,000
Crosswise	30,000
Impact Strength, Ft-Lb per In. Notch	
Edgewise, Lengthwise	7.0
Edgewise, Crosswise	6.0
Bonding Strength, Lb	1,500
Dielectric Strength	
Parallel to Laminations, KV	45
Perpendicular to Laminations, VPM	200
Water Absorption, %, 24 Hr	
1/16 In.	2.00
1/8 In.	1.75
1/2 In.	1.50
Dissipation Factor D-24/23	0.032
Dielectric Constant D-24/23	6.7
Volume Resistivity C-96/35/90	25,000
Surface Resistance C-96/35/90	250
Arc Resistance	130-180 sec



This lead-bearing steel is available cold drawn in various size ranges in rounds and hexagons.

Lead-Bearing Steels Have Good Machinability

Two new lead-bearing steels have been placed on the market by *La Salle Steel Co.*, 1412 150th St., Hammond, Ind.

Super La-Led, now available in limited quantities, is a free-machining, open-hearth steel containing about 1/4 lead and nearly 1/2% sulfur. It is said to have the highest sulfur content of any steel produced commercially in this country. A number of production tests have shown that the new steel machines 80% faster than B1113. In addition to its use for regular steel applications, the new steel is expected to replace brass because of its exceptional machinability. Where brass has been used primarily for its machinability, and corrosion is not a factor, La-Led will usually produce a comparable part at lower cost.

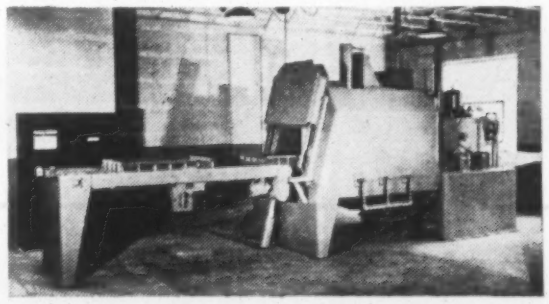
Leaded TS 4140 Modified is a lead-bearing alloy with improved machinability made possible by the addition of lead. This steel is said to machine one-third faster than comparable non-leaded grade. Experience indicates that its heat treating characteristics, hardenability and mechanical properties are not appreciably affected by the addition of the lead.

Heat Treating Unit Features Automatic Sealed Atmosphere

A new medium sized heat treating unit of 500 lb per hr capacity for bright heat treating, carburizing, carbonitriding, martempering and annealing operations has been announced by *Ipsen Industries, Inc.*, 715 S. Main St., Rockford, Ill. Similar in design to other company heat treating units, the new model T-500 is available for either electric or gas-fired operation. It features automatic sealed atmosphere and temperature control, and automatic transfer of work from heat through the quenching, or cooling cycle. A semi-automatic loader is provided as standard equipment with loading space for two work trays.

The unit is designed with the quench tank directly connected to the heating chamber, separated by an automatic air-draulic-operated intermediate door. Recessed in the hearth, power driven endless chains equipped with protruding lugs, transfer the work trays from the heating chamber onto an elevator rack over the quench tank. When idle, the section of chain equipped with lugs remains out of the heat zone below the hearth. As the transfer cycle is initiated, the cold chain and lugs move into position in contact with the work trays. Since the hot chain moves freely beyond the driving sprockets before load is applied, any excessive stretch or distortion is eliminated, an important feature that insures long service life.

Both the furnace and the quenching, or cooling, chambers are operated in a sealed controlled atmosphere supplied by endothermic generator equipment. Work is transferred from heat to the quenching chamber without breaking the atmosphere seal.



The versatility of this heat treating unit permits handling a wide range of work requirements on a production basis.

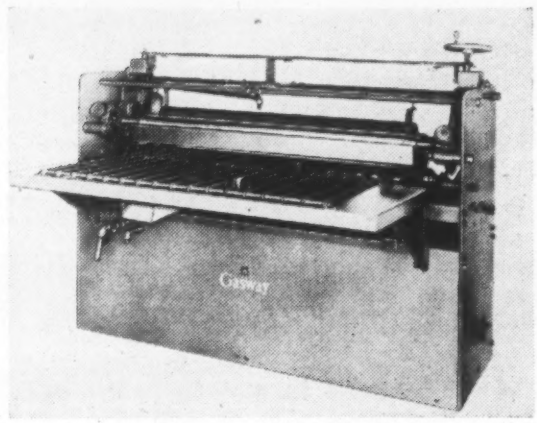
These exclusive features are said to assure highly uniform results and produce work that is exceptionally bright and scale-free, eliminating extra handling, fixturing, buffing and cleaning operations.

Coater Handles Wide Range of Materials

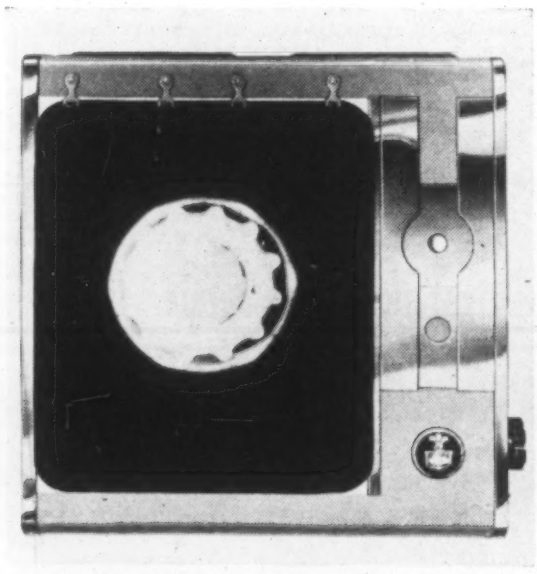
The new 32-B Gasway Rollcoat Finisher recently announced by *Gasway Corp.*, 6465 N. Ravenswood Ave., Chicago 26, is said to coat material up to 48 in. in width and 3 in. in thickness at speeds of 30- to 90-ft of linear travel per min. Higher or lower speeds are available, but only on special order.

According to the company, the ability of the coater to handle a wide range of materials and material sizes at varied speeds is due to the extreme flexibility of its material handling kits. These six accessory kits make it possible to use the finisher in practically any type of production coating line where flat material is finished and controlled thickness of the coating is necessary.

Kits include a standard feed table with adjustable edge guide; a feed conveyor kit that can be added to the feed table, making it into a short belt feed unit; a delivery table conveyor kit that can be mounted on the rear of the machine to carry small finished pieces far enough away from the machine to permit them to drop onto a drying conveyor; a pair of driven feed rolls that can be mounted on the front of the machine in place of the feed table; an extra long feed table with multiple drive rolls that can be added for handling long and heavy sheets; a brushing unit with dust removing fan that can be added to the long feed table; a paint circulating pump that can be added to deliver paint to the coating roll.



This finisher coats material up to 48 in. wide and 3 in. in thickness at speeds of 30- to 90-ft of linear travel per min.



The intense illumination of this illuminator permits maximum visualization and evaluation of obscure details.

High Intensity Illuminator for Industrial X-ray Film

A new high intensity illuminator which is said to make x-ray film inspection of industrial parts quick, easy and accurate, has been announced by *Keleket X-Ray Corp.*, 225 W. Fourth St., Covington, Ky. Radiographs of the thickest of structures now become plainly visible, particularly important in nondestructive inspection of dense metals, steel forgings, lead, copper, etc. This is accomplished by the even light intensity, 20 times greater than conventional viewers.

A full 14- by 17-in. viewing surface permits inspection of the largest films. Critical examination of small areas is accomplished before a 3-in. spot of four times the overall intensity. This intense illumination permits maximum visualization and evaluation of obscure details—even in films with a density range exceeding 4.5 density.

A built-in adjustable mask is provided for the special viewing spot, separate masks for films of smaller than 14- by 17-in. size viewed on the large area. Smooth roller clips hold film firmly, yet do not scratch. Cool front operation allows extended viewing without danger of curling or buckling film. Foot switch control, stepless voltage brightness control and use of standard photo-flood lamps are other features. Accessories include clips and drip pan for wet examination of films.

New Polystyrene Has High Toughness

A new polystyrene formulation designed to bridge the gap between regular and high impact polystyrenes has been announced by the Chemical Div., *Koppers Co., Inc.*, Pittsburgh 19. Developed to satisfy the need for a thermoplastic that has intermediate properties, the new modified polystryrene exhibits a marked increase in toughness over regular polystyrenes. At the same time, moldings made with it are said to have smoothness and surface luster nearly equal to that of regular polystyrenes.

According to the company, the general toughness of the new material is expected to make it especially desirable for moldings which may not require premium high impact polystyrene, but in which regular grade polystyrene has presented some breakage problems in use, plant handling or shipping. Heat resistance in the modifying polystyrene is also said to be somewhat improved over that of fully modified polystyrenes MC 185 and MC 301. In moldability, the new formulation molds easier than the more shock resistant polystyrenes, though not quite as easily as regular polystyrene.

Fields in which the modified polystyrene is expected to be valuable are in the making of housewares, appliances, battery cases, air conditioning housings, radio and television components, refrigerator parts, packaging items, toys, etc.

Koppers MC 401 attains its toughness and shock resistance from increased elongation and flexibility. This, however, is accompanied by a slight modification in certain other physical properties. To assure satisfactory application of this new plastic, careful consideration should be given the exact physical properties. The product is available immediately in all standard opaque colors, but not in crystal or translucent.

New Materials and Equipment continued

Diffraction Powder Camera Adaptable to Standard X-ray Equipment

Two new x-ray diffraction powder cameras embodying a number of unique features have been announced by the Research & Control Instruments Div., *North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y. Available in two sizes, 114.59-mm and 57.3-mm dia, these cameras are said to record up to 17 Angstrom spacings with copper radiation, with low air scatter and unusually clear patterns in the forward reflection region.

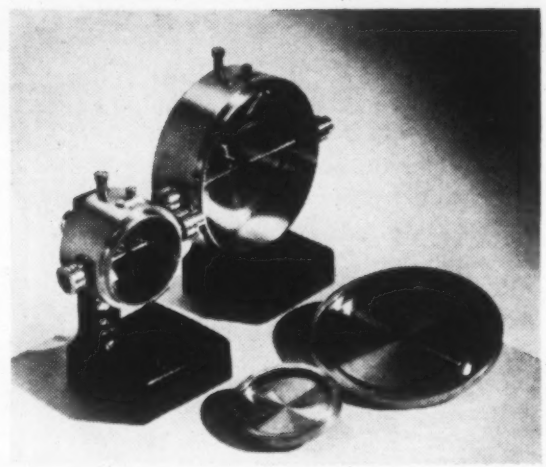
Adaptable to almost all makes of standard x-ray equipment, the cameras can be readily adjusted to fit most conventional camera tracks. They are easily aligned with the x-ray beams, collimators are interchangeable, snap-on light-tight covers are easily removed and replaced, the cameras use standard 35-mm film, and bodies are satin chromium finished.

One important feature involves a film mounting device which permits use of the Straumanis calibration technique or the Wilson method, which Philips introduced whereby film is positioned for calibration without high angle lines.

Cone-seated in the main camera housing, the two collimators consist of three components which are individually replaceable. A convenient pulley is provided so that the specimen can be rotated by attaching a separate external drive motor.

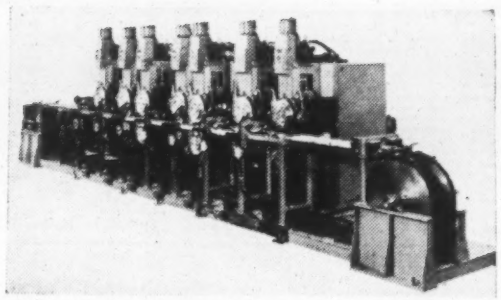
The carefully computed beam system gives extremely low general background, and films exhibit exceptional cleanliness in the low angle forward reflection region, background being essentially linear to the circumference of the beam receiving tube. To reduce external scatter, an integral cup trap is provided on the collimator. An auxiliary lens, which mounts on the collimator cup and is focussed on the specimen position, permits accurate centering of the specimen prior to exposure.

A fluorescent screen, covered by protective lead glass, permanently mounted at the outer end of beam receiving tube, facilitates camera alignment and also allows observation of the specimen shadow during exposure.



This powder camera for x-ray diffraction is adaptable to almost all makes of standard x-ray equipment, and can be readily adjusted to fit most conventional camera tracks.

Multiple Seam Resistance Welder for Refrigeration Manufacture



This multiple seam resistance welder makes the liner for the cold wall of the low temperature refrigeration compartment by welding aluminum to aluminum.

The *Taylor-Winfield Corp.*, Warren, Ohio, has announced the development of a new multiple seam resistance welder that is currently being used for refrigerator manufacture. The welder makes the liner for the cold wall of the low temperature refrigeration compartment by welding aluminum to aluminum.

As the 0.032-gage, 13- by 60-in. plate travels through this machine, six formed aluminum channels, ⅜ in. wide by 60 in. long with ½-in. legs are welded to the plate—in simultaneous operation. These channels hold metal tubing through which refrigerant passes and by this means, heat is extracted from the low temperature compartment into the refrigerant.

A time-saving feature of the welder is a multiple high-speed wheel dressing unit which is said to remove the aluminum picked up on the copper welding wheels.

The entire welder is 32 ft long. The approximate rate of operation is 120 panels per hr.

Rubber-Filled Phenolic Molding Compound Readily Absorbs Shock

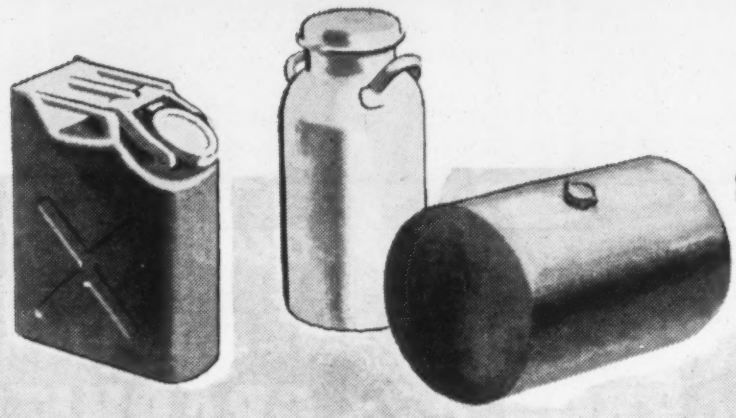
A new flexible type phenolic molding compound, known as Durez 14780 Black, has been announced by *Durez Plastics & Chemicals, Inc.*, North Tonawanda, N. Y. The material has a low modulus of elasticity which permits its use for molding in thin sections around inserts. Having a synthetic rubber filler, it absorbs shock more readily than standard wood-flour or flock-filled materials.

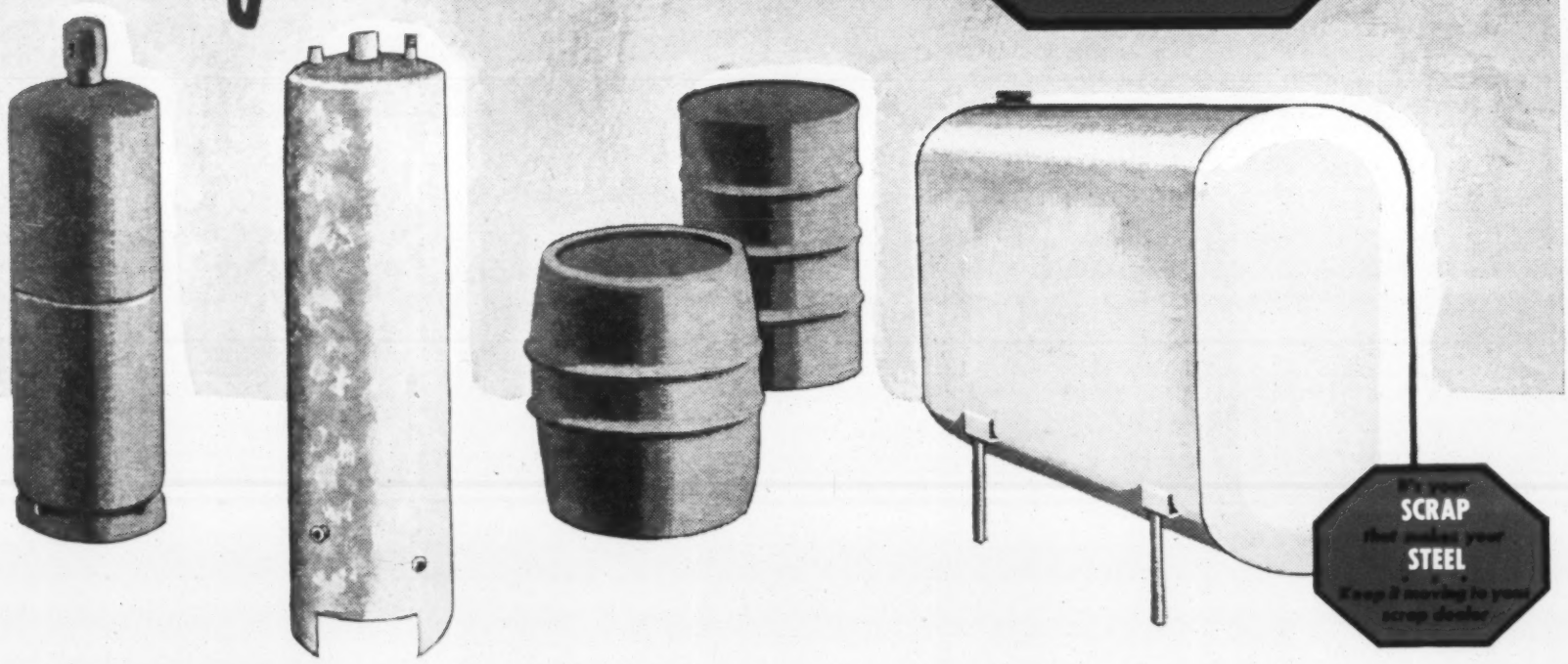
Durez 14780 is said to mold equally as well by compression or closed mold molding, and can be preformed in any automatic preforming equipment. While cure time depends upon the thickness of the molded part, it is generally somewhat longer than for general-purpose types of phenolic molding compounds. Molding temperatures of 290 to 310 F are recommended. Preheating characteristics are claimed to be very similar to general-purpose phenolics, and surface finish is good. Flexural strength is 9,000 psi (min) and tensile, 6,000 psi (min). Impact strength is said to be 50% higher than average general-purpose materials.

The compound is not recommended for applications where continuous heat of more than 250 F is required.

(More News on page 142)

Containers have LONGER LIFE LIGHTER WEIGHT when fabricated with N-A-X HIGH-TENSILE STEEL





MAKE A TON OF SHEET STEEL GO FARTHER
Specify— N-A-X HIGH-TENSILE STEEL
... And "MAKE YOUR PRODUCT LAST LONGER"

Containers and pressure vessels assure greater service when made of N-A-X HIGH-TENSILE steel. The durability of this low-alloy steel, its greater resistance to corrosion and abrasion, and its exceptional fabricating and welding qualities are important characteristics. The greater strength of N-A-X HIGH-TENSILE steel permits fabrication of containers from thinner sections—reducing costly deadweight to a minimum. If you are interested in effecting economies in barrels, drums or cylinders, investigate N-A-X HIGH-TENSILE steel.

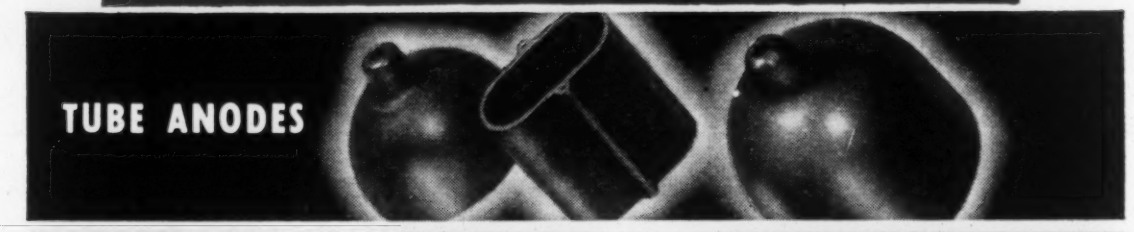
GREAT LAKES STEEL CORPORATION

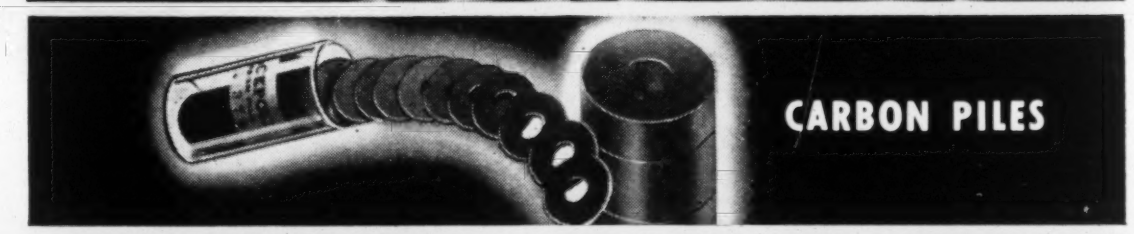
N-A-X Alloy Division — Ecorse, Detroit 29, Mich.

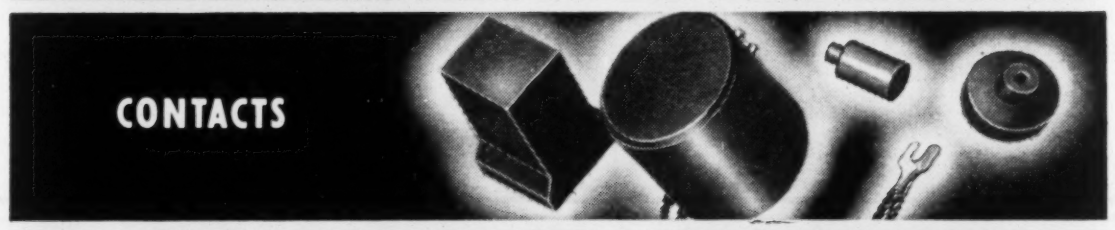
NATIONAL STEEL CORPORATION

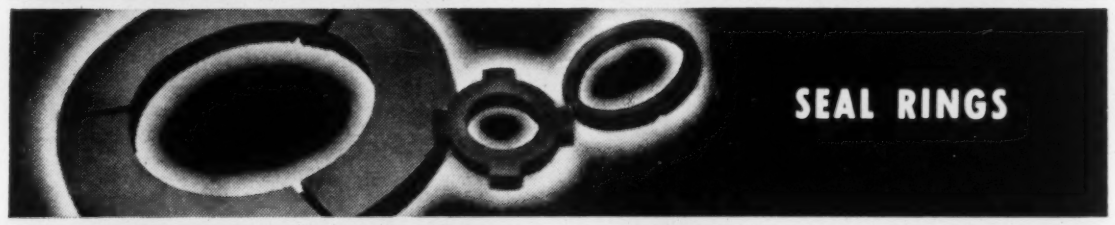
Save
CRITICAL MATERIALS
Improve
PERFORMANCE WITH
CARBON and GRAPHITE!

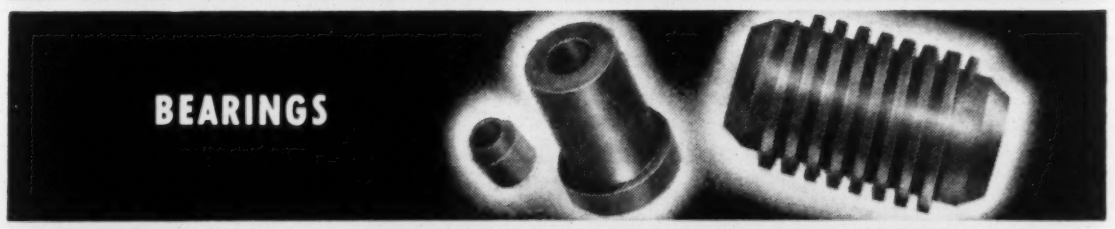
Chemically, electrically and mechanically, Stackpole carbon and graphite components offer a maximum of the desirable properties of metallic or non-metallic materials and a minimum of their disadvantages! Problems of friction, temperature, arcing and corrosion—and others—can frequently be solved better and at less cost.











Write on letterhead for the big Stackpole Carbon-Graphite Booklet 40, to Stackpole Carbon Co., St. Marys, Pa.

STACKPOLE

"Everything in Carbon but Diamonds"

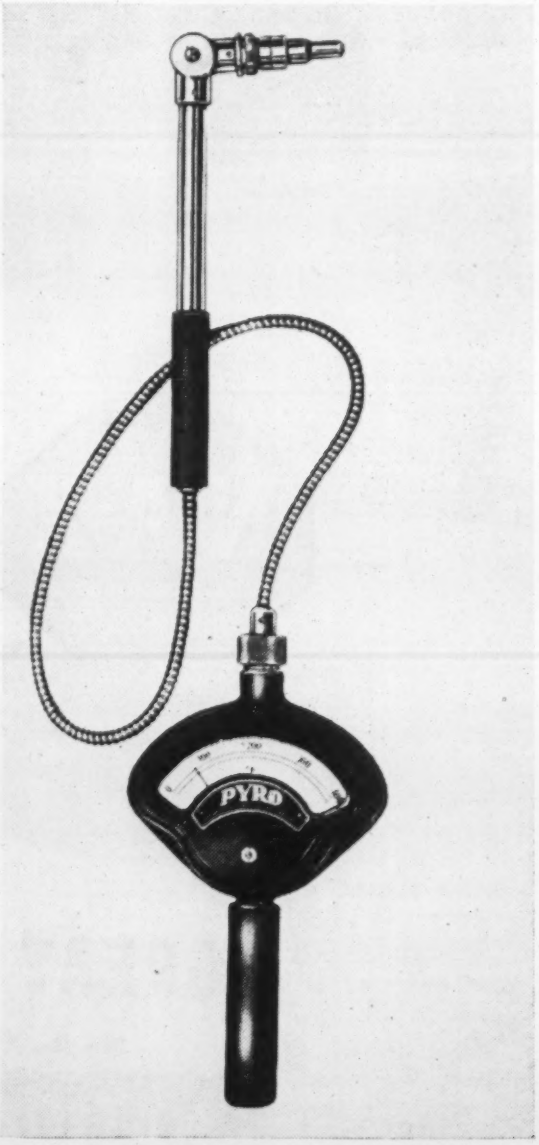
New Materials and Equipment

Surface Pyrometer for Precision Temperature Measurement

Pyrometer Instrument Co., Bergenfield, N. J., has announced the introduction of a new surface pyrometer for accurate surface and sub-surface temperature measurement. Called the new Pyro surface pyrometer, this instrument is said to incorporate features not found in any other instruments of this type. It is available with a selection of 14 different types of thermo-couples and extension arms to meet every surface and sub-surface temperature measuring problem. It can be equipped with a new quick-change connector which permits the thermocouples to be snapped and locked onto the extension arms in a matter of seconds, without any tightening needed. Thermocouples are interchangeable without adjustment or recalibration.

Another feature of the units is the lock-swivel which permits locking thermocouples at any desired angle without danger of their jarring loose while the temperature measurement is being made.

Temperature readings can be taken readily from the large 4¾-in. direct-read-



This pyrometer incorporates many new features.

In the New Unit Rig Drawworks Drum Clutch

MEEHANITE® CASTINGS MEAN DEPENDABILITY - QUALITY

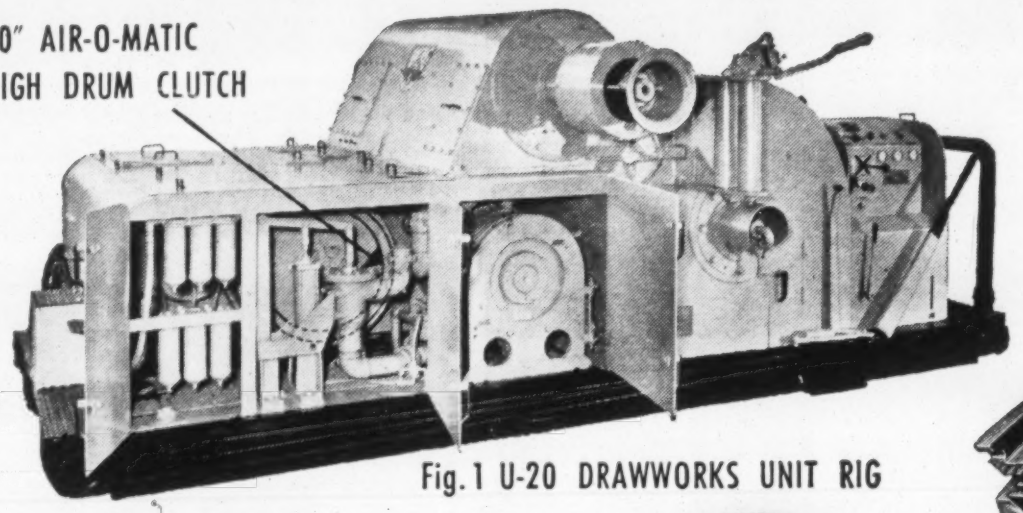
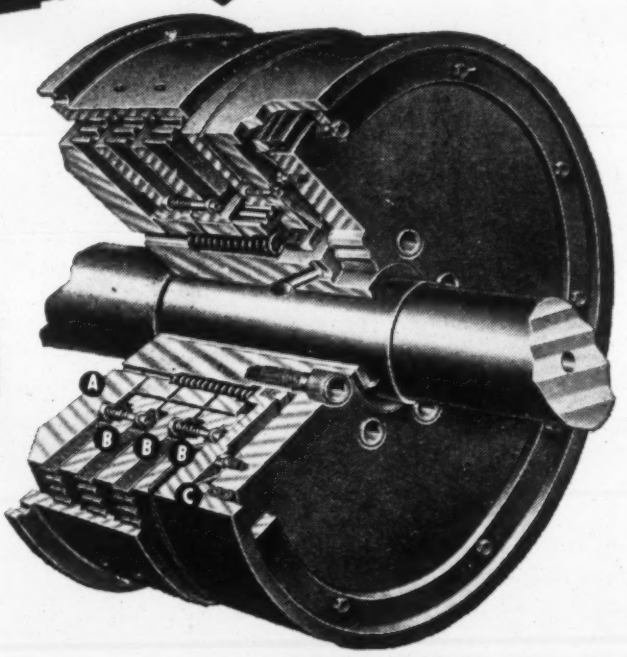


Fig. 1 U-20 DRAWWORKS UNIT RIG



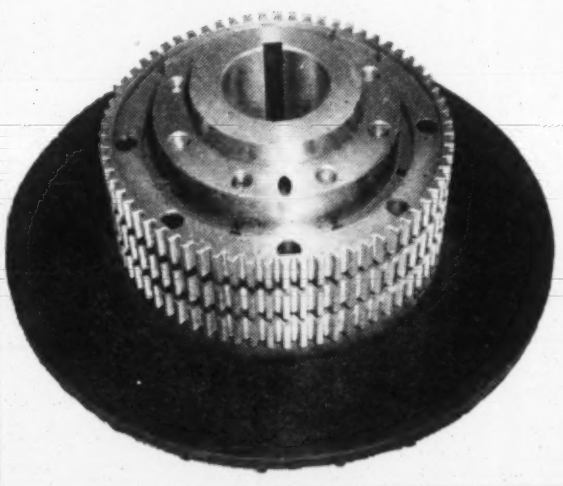


Fig. 2 HUB and BACK PLATE

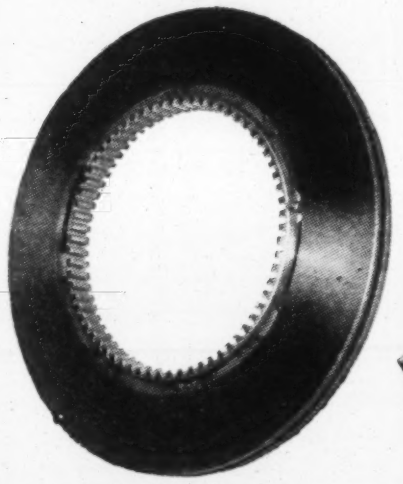


Fig. 3 FLOATING PLATE

Fig. 4 CLUTCH ASSEMBLY

The proof that in important new designs and improved products such as the U-20 Unit Rig (Fig. 1), manufactured by Unit Rig Company, Tulsa, Oklahoma, Meehanite castings are regularly meeting rigid specifications is quickly provided by this example.

A feature of the U-20 Rig is a 30-inch Air-O-Matic clutch vital to its smooth dependable operation. In this clutch the following Meehanite castings are specified:

1. Hub and back plates (Fig. 2)
2. Floating plates (Fig. 3)
3. Pressure plate (Fig. 4)

To these components Meehanite castings contribute high strength, good anti-friction properties, machinability and uniform high quality.

For proof that Meehanite castings can improve your product write for the Meehanite Handbook.

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

MEEHANITE® NEW ROCHELLE, N. Y.

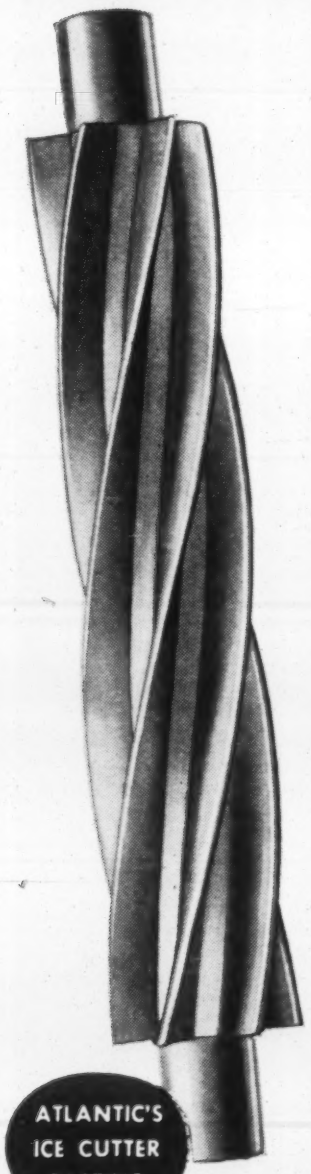
"This advertisement sponsored by foundries listed above."

COLD FACTS

about YORK'S new ICE CUTTER

YORK FLAK-ICE AUTOMATIC ICE MAKER, MODEL DER-2

ICE HARVESTING SYSTEM



ATLANTIC'S ICE CUTTER CASTING

AN IMPORTANT COMPONENT of York Corporation's most recent development, the York-Flaklce Automatic Ice Maker, is Atlantic's ice cutter casting. It cuts the ice into curved flakes... so delicate they will not damage or puncture delicate rose petals.

YORK'S ORIGINAL CONCEPTION of the ice cutter... a vital part of the ice harvesting system ...consisted of three stainless steel parts which had not only to be machined, but welded together.

ATLANTIC'S ENGINEERS suggested a design that eliminated these costly operations and increased the productive efficiency of the ice cutter. Six spiral blades on a center shaft were all plaster mold cast in *one piece* of Atlantalloy #31 High Tensile Manganese Bronze... an alloy of great endurance and strength.

York will testify that Atlantic's all-in-one-piece ice cutter casting surpassed all requirements for high physical values, closely-held tolerances, satin-smooth finish, fine-grained structure, clean-cut surfaces... and afforded them substantial savings over former costs.

Find out how the Atlantalloy plaster mold casting process can help solve some of your problems' Write for a free copy of "High Quality Precision Castings for Industry" today!

ATLANTIC CASTING and ENGINEERING CORP.

Established 1937

721 Bloomfield Avenue • Clifton, N. J. • PRescott 9-2450

New Materials and Equipment

ing dial. In addition, the accuracy and precision of readings is assured due to the automatic cold end compensation feature of the instrument.

The new pyrometer is shock, dust and moisture resistant, and the shielded steel meter housing is designed to withstand rough usage. It is available in five different temperature ranges for all laboratory and plant use.

Electric Box Furnace Good at 2000 F

The *Cooley Electric Manufacturing Corp.*, 38 S. Shelby St., Indianapolis, has announced a new bench type furnace made for heat treating to 2000 F. The VK 7 furnace has heating elements of 6.5-kw capacity at 220 v, single phase, on all four sides of the chamber and in the door which is said to provide even heat distribution and close temperature uniformity.

The elements are of the company embedded design which protects the element wire against atmospheric attacks and mechanical breakage. Renewal of elements can be made without dismantling the furnace, thus avoiding extensive down time. Chamber dimensions of the model are 10 by 6 by 18 in.

Slope Control for Exacting Welding Applications

Weltronic Co., 19500 W. Eight Mile Rd., Detroit 19, has announced the availability of a control accessory designed for the more exacting critical welding applications involving aluminum, magnesium and dissimilar metals. Its use is recommended whenever MIL-W-6860 specifications must be met. Synchronous precision control with positive and negative slope control has been certified and is capable of qualifying a resistance welding machine on single phase.

Slope control is available as an accessory or as a built-in feature. Plug-in connectors permit easy replacement. NEMA 7B and 9B sequence timers are interchangeable. Slope control is beneficial in reducing tip pickup, thus permitting many more welds before electrodes must be cleaned.

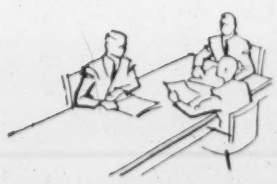
The control provides 7B or 9B sequence timer, phase shift heat control and slope control designed to give a slope of the current at the beginning of weld time, a fixed level heat current value dur-

PLASTICS

add sales appeal!

luxury note in the Beauty World... —made of STYRON 475

Because he wanted strikingly beautiful packaging, the maker of Erno Laszlo cosmetics chose Styron 475 as the finest material available to attain that end. The finished containers dramatically express a restrained elegance so befitting these exquisite, high-style cosmetics. These sales-producing packages were achieved by the manufacturer, the molder and Dow working together, pooling their talents to reach the desired result. Similarly, this "working together" with lightweight, tough, flexible Styron 475 may help you improve *your* packaging, too. Such packaging will reflect your product's character and be abreast of today's need for harder sell at point-of-sale.



let's work it out together!

Write Today

THE DOW CHEMICAL COMPANY

Plastics Department—PL 425E

MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Atlanta
Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

DID you know?

More than 4 million rooms were covered with plastics wall tile this year . . . since this use for plastics began in 1945 with approximately 250 rooms . . . a growth of 1,600 per cent!

A plastics ukulele strummed under water continued in perfect tune when played recently on a famous television program. The conventional ukulele used to require 225 parts for assembly of its 30 inches. Polystyrene has made it possible to produce, in just 6 minutes, a fine quality counterpart having only 7 parts.

Nearly every family in the United States now has a refrigerator. Plastics have made it possible to maintain 3 different temperature zones in the latest models. More than 22 pounds of plastics are incorporated in the average refrigerator today.

DOW

A regular service of The **COOPER ALLOY** Foundry Co., Hillside, N. J.

TECHNICAL TOPICS

BASIC PRINCIPLES OF CORROSION

Norman S. Mott

Chief Chemist and Metallurgist

Aqueous corrosion is the electrochemical destruction of a metal by its chemical environment. It may take place in two forms, general over-all corrosion, or localized attack. In this corrosion picture, metals and alloys fall into two groups: those which resist corrosion because of their low position in the electromotive series with respect to hydrogen, and those which resist corrosion because of their ability to build up a condition of surface passivity. This condition of passivity confers on the metal or alloy, a degree of nobility, placing it below hydrogen in the electromotive series and therefore making it greatly resistant to acids and other corrosive chemicals.

The stainless steels with their high chromium content represent a class of corrosion resistant materials which rely mainly on their surface condition of passivity for resisting attack.

Unfortunately, these stainless steels do not remain passive under all conditions, and become either borderline, i.e., active-passive, or completely active, and this depends upon the oxidizing power of the corrosive or upon its depassivating strength if it is of a reducing nature.

Localized corrosive attack may take place on stainless steels in various forms, such as intergranular, pitting, electrolytic or the concentration cell type of attack. Intergranular corrosion is a form of corrosion which takes place at the grain boundaries of austenitic stainless steels as a result of carbide precipitation at these boundaries due to adverse heating in the range of 900-1600° F. This is a phenomenon associated only with chromium carbide precipitation and may be obviated by the use of added elements, such as columbium or titanium, which form preferential carbides or by the carbide solution annealing heat treatment consisting of water quenching from 1950-2150°F. It may also be somewhat alleviated thru chemical composition balance by the introduction of 4-10% of ferrite in the austenitic structure. Intergranular corrosion does not take place in the martensitic or ferritic types of stainless steels.

Pitting corrosion is a localized breakdown of the passive surface condition and is caused by segregation of alloy components, carbide precipitation thru improper heat treatment, scale particles or inclusions, local concentration of the corrosive, or by stresses set up by mechanical working. It occurs more frequently in stagnant solutions and is promoted thru the mechanism of the concentration cell type of corrosive action. Certain types of corrosives such as chlorides and other halides have a great tendency to cause pitting in stainless steels.

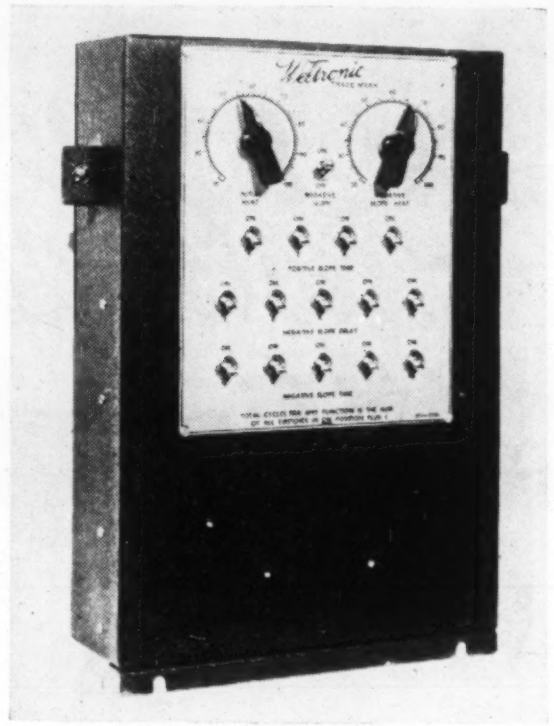
When dissimilar metals are placed together in a corrosive, an electric current is set up at the junction and an electrolytic type of corrosion results which is proportional to the amount of current flowing. The intensity of this current flow is greater when the metals are further apart in the electrochemical series and varies with the relative size of the exposed areas.

Electrolytic corrosive action may also take place by current flow formed thru differences in the metal-ion concentrations resulting from the corroding metal, or thru differences in oxygen concentration, these occurring in crevices, pits, or recesses in the metal, or between different metals, or even between metals and non-metallic objects. This is generally known as a concentration cell type of attack or may be otherwise designated as metal-ion cencentration cell, oxygen concentration cell and crevice or contact corrosion.

Copies of this article reprinted on heavy stock for convenient filing are available on request.

The **COOPER ALLOY** Foundry Co., Hillside, N.J.

New Materials and Equipment



This control accessory is designed for the more exacting critical welding applications involving aluminum, magnesium and dissimilar metals.

ing a portion of the weld, and decays the current at the end of the weld.

Adjustors to control the current values of initial heat, maximum heat, final heat as well as the rate of increase and rate of descent are furnished. Control is available with 600- or 1200-frame contactor.

Anti-Rust Paints Can Be Applied Directly on Rust Surfaces

A new line of chromate anti-rust paints to be marketed under the trade name, Overust, has been announced by *Chem Industrial Co.,* 3784 Ridge Rd., Brooklyn 9, Ohio. The new paints feature a high quality Menhaden vegetable oil base with special chromate pigments added to give extra protection against rust. They are said to provide a much greater degree of protection against rust than previously available protective coatings.

Available in red, gray, green, black, aluminum and clear, the paints are recommended for use on any kind of metal, interior or exterior. According to the manufacturer, the paints can be applied directly over rusted surfaces without wire brushing or sandblasting, and one coat is sufficient to prime, penetrate and seal all metal surfaces. Chromates in Overust paints possess great affinity for metal and are said to stop the most severe rust attacks and to resist

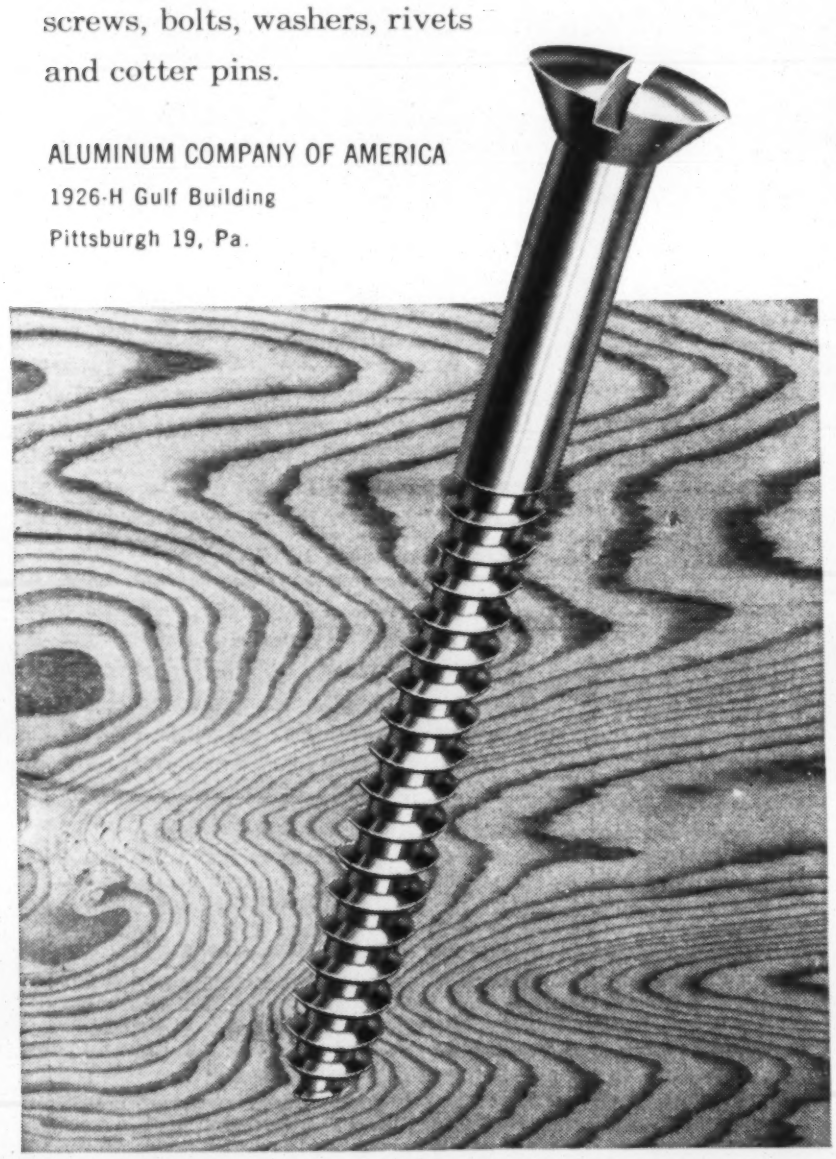
ALCOA Fasteners...

corrosion-resistant

all the way through

If you use Alcoa Aluminum Fasteners, you are safe from the galvanic corrosion that may come with fasteners of other metals in aluminum assemblies. They also resist atmospheric corrosion in nonmetallic assemblies. This low-cost, quality line includes a complete selection of nuts, screws, bolts, washers, rivets and cotter pins.

ALUMINUM COMPANY OF AMERICA
1926-H Gulf Building
Pittsburgh 19, Pa.



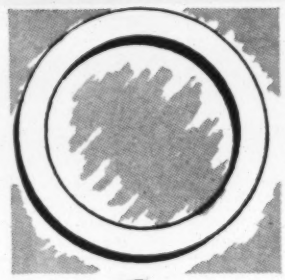
ALCOA ®

Fasten Aluminum with

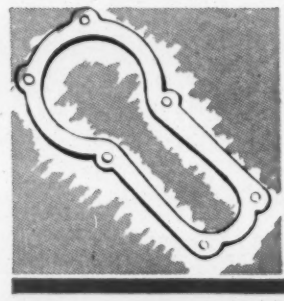
Alcoa Aluminum Fasteners

ALCOA TELEVISION—CBS Network, 6:30 to 7:00 P. M. EDST every Sunday on most stations—8:30 to 9:00 P. M. in far West

A new type Cohrlastic gasketing



For
GASKETS • HEAT SEALING JAWS • LOW TEMPERATURE SERVICE • PRESS COVERS • ELECTRIC INSULATION • DIAPHRAGMS • CONVEYOR BELTS • BOILER SEALING • EXPANSION JOINTS • DUCTING



For Operating Temperatures −100° to +500°F.

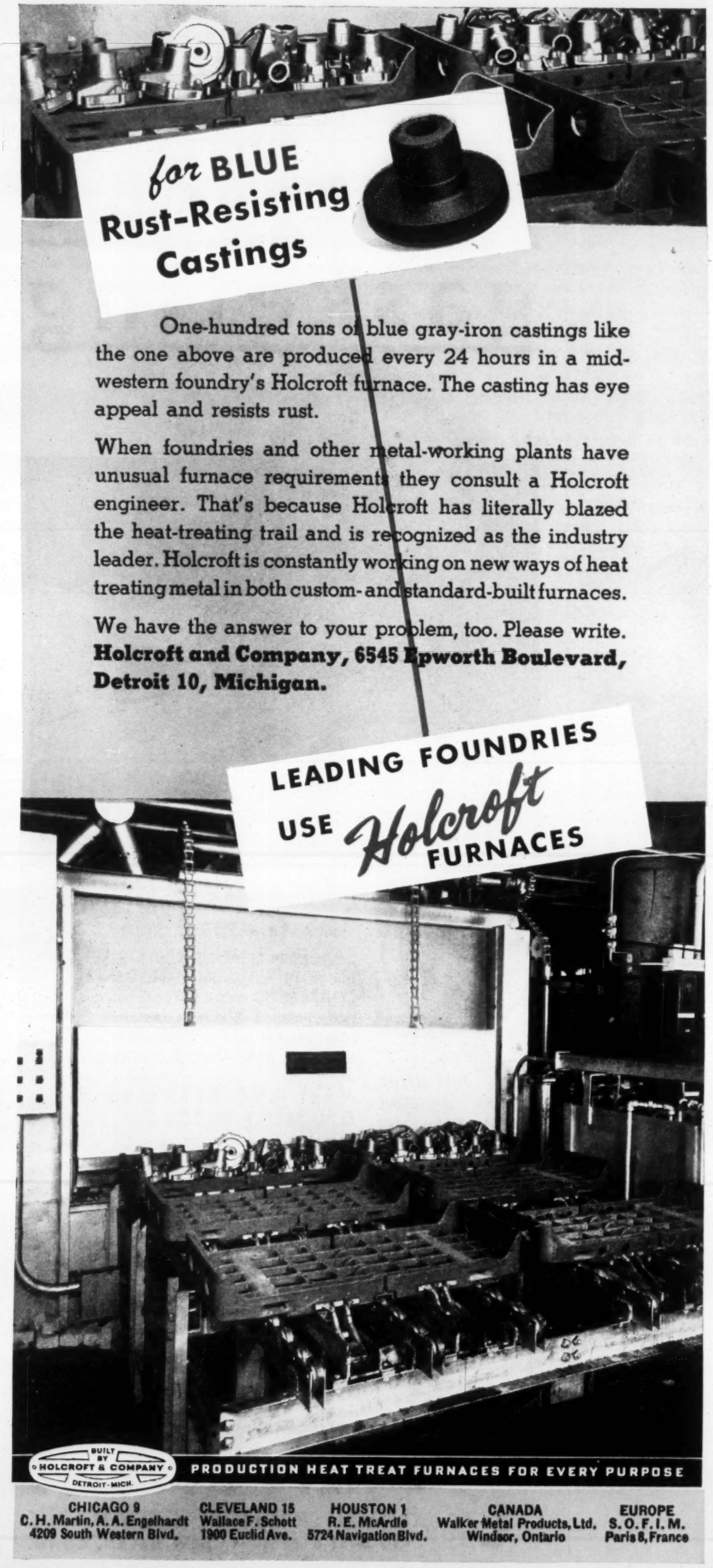
Connecticut Hard Rubber chemists have built real temperature resistance into COHRLASTIC fabrics. These silicone rubber-coated fiberglas materials remain soft, flexible and resilient over an extremely wide temperature range.

Meet AMS 3315 and QM MIL-T-10035A

Their excellent resistance to hot oil makes them an ideal gasketing under conditions that cause other materials to harden and leak. Thousands of applications have proved their effectiveness. Equally good sealing is obtained at very low temperatures . . . an important feature for winterization, aircraft or refrigeration work.

COHRLASTIC fabrics may be readily cut to size or died out to form gaskets . . . or are obtained in the form of finished gaskets. Send for technical data sheets giving physical properties.

THE Connecticut HARD RUBBER COMPANY
419 EAST STREET • NEW HAVEN, CONN.



One-hundred tons of blue gray-iron castings like the one above are produced every 24 hours in a mid-western foundry's Holcroft furnace. The casting has eye appeal and resists rust.

When foundries and other metal-working plants have unusual furnace requirements they consult a Holcroft engineer. That's because Holcroft has literally blazed the heat-treating trail and is recognized as the industry leader. Holcroft is constantly working on new ways of heat treating metal in both custom- and standard-built furnaces.

We have the answer to your problem, too. Please write. **Holcroft and Company, 6545 Epworth Boulevard, Detroit 10, Michigan.**

New Materials and Equipment

moisture, temperature changes, acids and fumes. They can be applied by either brush or spray.

Where colored anti-rust paints are desired, Overust can be used without the customary colorless primer coat which is required for ordinary colored paints.

Vacuum Furnaces for Metals Processing

Recent developments in high vacuum processing include new methods for heating metals under vacuum. Contaminants affecting metal properties, such as dissolved gases, chemically combined gases, and occluded gases, are eliminated in the process, and the properties of metals are often improved. Titanium, zirconium, copper, iron and many rare metals respond particularly well to vacuum processing.

A complete line of vacuum furnaces for metals processing is now available from *F. J. Stokes Machine Co.,* 5500 Tabor Rd., Philadelphia 20. The furnaces are electrically heated and are built for one of three purposes: resistance heating, induction heating or arc melting.

Resistance heated furnaces are used to process metals in a solid form at temperatures up to approximately 1800 F. Induction heated vacuum furnaces are used to process metals in a molten state at temperatures up to approximately 3200 F. Higher temperatures can be produced by this method, but the limitations of refractories set the temperature limit.

Arc melting furnaces are used to form ingots from metal sponge and powdered metal compacts at extremely high temperatures. Melting is normally done in an argon atmosphere after high vacuum has completely out-gased the material.

Small Hammer Driven Rivet Finding Many Applications

Responding to a demand for a small size hammer-driven blind rivet, Southco Div., *South Chester Corp.,* 1418 S. Penn Sq., Philadelphia 2, has announced the addition to its line of a 1/8-in. dia. drive rivet. Like the 3/16- and 1/4-in. dia versions now in production, the 1/8-in. dia rivet is installed merely by tapping home a pin with an ordinary hammer. This one-man operation requires no bucking or special tools, and is done without

6 reasons why

NIALK® TRICHLORethylene is your best buy for Fast, Low-Cost metal degreasing

1. QUICK ACTING . . . Cleans and dries in record time. And after rapid degreasing of surfaces, metal is warm, dry and ready for further processing.

2. SAVES MONEY ON POWER . . . Low boiling range means quick vaporization. Can be heated by gas, steam, or electricity. Produces a concentrated vapor at only 188°F.

3. SAVES MONEY ON SOLVENT . . . High vapor density means proper vapor level will be maintained in the degreasing machine. Result: more efficient cleaning with low solvent loss.

4. NON-FLAMMABLE . . . At room temperature there's no worry about fire when you take the ordinary precautions required in the handling of any chlorinated hydrocarbon.

5. STABLE . . . NIALK TRICHLORethylene can be used for all-purpose degreasing.

6. ECONOMICAL . . . Completely re-usable after distillation.

Make sure your metal parts are 100% grease-free. NIALK TRICHLORethylene leaves them clean, warm, dry, ready for immediate electroplating, painting, enameling, lacquering, rustproofing, heat treating, pickling, inspection or assembling.

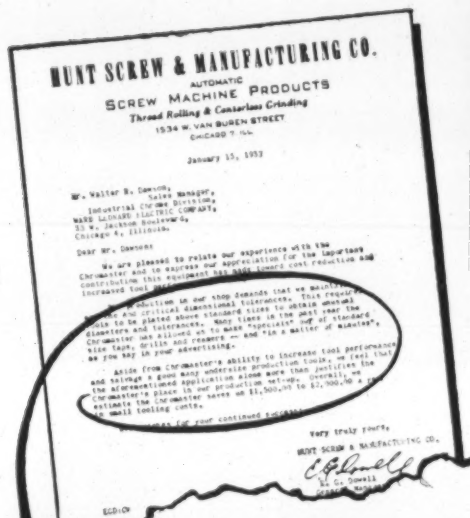
NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, N. Y.

NIALK Liquid Chlorine • NIALK Caustic Potash • NIALK Carbonate of Potash • NIALK Paradichlorobenzene
NIALK Caustic Soda • NIALK TRICHLORethylene • NIAGATHAL® (Tetrachloro Phthalic Anhydride)

"Saves $1,500 to $2,000 in small tool costs"

Here's how one manufacturer cuts costs and increases tool performance by using a Chromaster industrial chrome plating unit right in his own plant.



HUNT SCREW & MANUFACTURING CO.
AUTOMATIC
SCREW MACHINE PRODUCTS
Thread Rolling & Centerless Grinding
1534 W. VAN BUREN STREET
CHICAGO 7, ILL.

January 15, 1953

Mr. Walter R. Dawson,
Sales Manager,
Industrial Chrome Division,
WARD LEONARD ELECTRIC COMPANY,
31 W. Jackson Boulevard,
Chicago 4, Illinois.

Dear Mr. Dawson:

We are pleased to relate our experience with the Chromaster and to express our appreciation for the important contribution this equipment has made toward cost reduction and increased tool performance.

The production in our shop demands that we maintain extreme and critical dimensional tolerances. This requires tools to be plated above standard sizes to obtain unusual diameters and tolerances. Many times in the past year the Chromaster has allowed us to make 'specials' out of standard size taps, drills and reamers — and 'in a matter of minutes'. Over-all, we estimate the Chromaster saves us $1,500.00 to $2,000.00 a year in small tooling costs.

Aside from chromaster's ability to increase tool performance and salvage a good many undersize production tools, we feel that the aforementioned application alone more than justifies the Chromaster's place in our production set-up. Over-all, we estimate the Chromaster saves us $1,500.00 to $2,000.00 a year in small tooling costs.

Thanking you for your continued co-operation, we are

Very truly yours,
HUNT SCREW & MANUFACTURING CO.
E. G. Dowell
E. G. Dowell
General Manager

EGD:ch

"The production in our shop demands that we maintain extreme and critical dimensional tolerances. This requires tools to be plated above standard sizes to obtain unusual diameters and tolerances. Many times in the past year the Chromaster has allowed us to make 'specials' out of standard size taps, drills and reamers—and 'in a matter of minutes'. Over-all, we estimate the Chromaster saves us $1,500.00 to $2,000.00 a year in small tooling costs."

writes E. G. Dowell, General Manager,
Hunt Screw & Manufacturing Co., Chicago, Ill.

Other users are increasing their production and profits with this simple, fast, low-cost industrial chrome plating process.

A Large Automotive Axle Company Reports:
"Using a Chromasol plated tap with 3½ minutes plating, we are now averaging 6,800 holes per set of taps for banjo housings. This has more than doubled our former 3,000 holes per set of 7/16-14 high-speed commercial ground taps."

An Electric Motor Manufacturer Says:
"We have been able to correct manufacturing errors by Chromasol plating to salvage one hundred electric motor shafts otherwise rejected as undersize."

A Manufacturer of Plumbing Fixtures Says:
"Chromasol plating has increased the life of our 8-32 machine screw tap, used in tapping a plumbing fixture, from 1,000 pieces to 6,000 pieces."

A Pump Manufacturer Says:
"Our deliveries of small pumps for the oil industry have been speeded as much as five days by depositing .0002" to .0005" Chromasol plate on shafts that would otherwise have been scrapped or sent out to a commercial chrome plating company. This operation in one instance permitted a $16,000 pump unit to be put into operation immediately."

There's reason after reason for installing Chromaster in your plant. It can mean dollar savings to you in increased production, minimized set-up and down-time on your machine tool operation. Normal life of your cutting tools and wear parts can be multiplied three to ten times by this amazing new and simplified method of chrome plating. 3½ minutes for the average job. There's a size Chromaster for every shop.

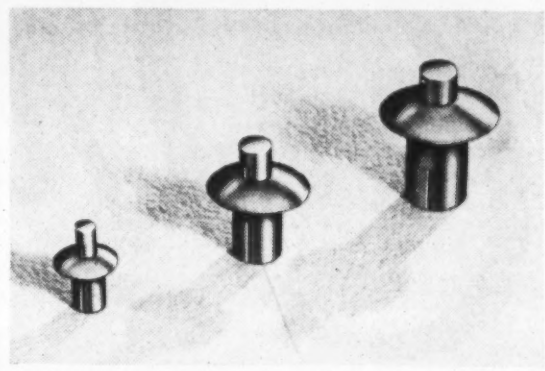
Chromaster

Ward Leonard Electric Co.
Industrial Chrome Division
16 South Street,
Mount Vernon, N. Y.

Please send information on industrial chrome plating with Chromaster.

NAME .....
COMPANY .....
ADDRESS .....
CITY ..... ZONE ... STATE .....

New Materials and Equipment



These ⅛-in. dia drive rivets are installed merely by tapping home a pin with an ordinary hammer.

need for access to the rear side of the work.

Driving the pin causes prongs at the end of the rivet to expand against the back sheet and form a permanent blind head that draws panels tightly together. With the pin driven flush, the outer head has a nice finished appearance—there are no stems to trim off or file, and installation requires no pulling, twisting or exploding.

Said to be equally effective in metal-to-metal or metal-to-wood installations, the ⅛-in. dia rivet is finding immediate application in such fields as electronics manufacture, case making, attachment of name plates, and general sheet metal work. Rivets are available in modified brazier or 100-deg countersunk head styles, with grip lengths from 1/32 to 13/32 in.

Can Sealer Accessory to Soldering Unit Effects Substantial Savings

The *Wasserlein Manufacturing Co., Inc.*, 126 W. Cass St., Joliet, Ill., has announced the availability of a new can sealer accessory to the Wassco Glo-Melt soldering unit. The new accessory is used for sealing all can-type containers used in the manufacturing of relays, condensers, crystals, transformers, etc., in the electronics field; and is expressly designed for use wherever soldered joints have to be made on cylindrical, rectangular or tubular metal housings.

According to the company, tests indicate a substantial all-round savings for industrial users of this new device. Production figures show it does a more uniform job 3 to 5 times faster than hand methods. Because the unit operates on the principle of resistance soldering, there is no waste (or vaporizing) of flux and no burn, shock or visual arc hazard to the production worker.

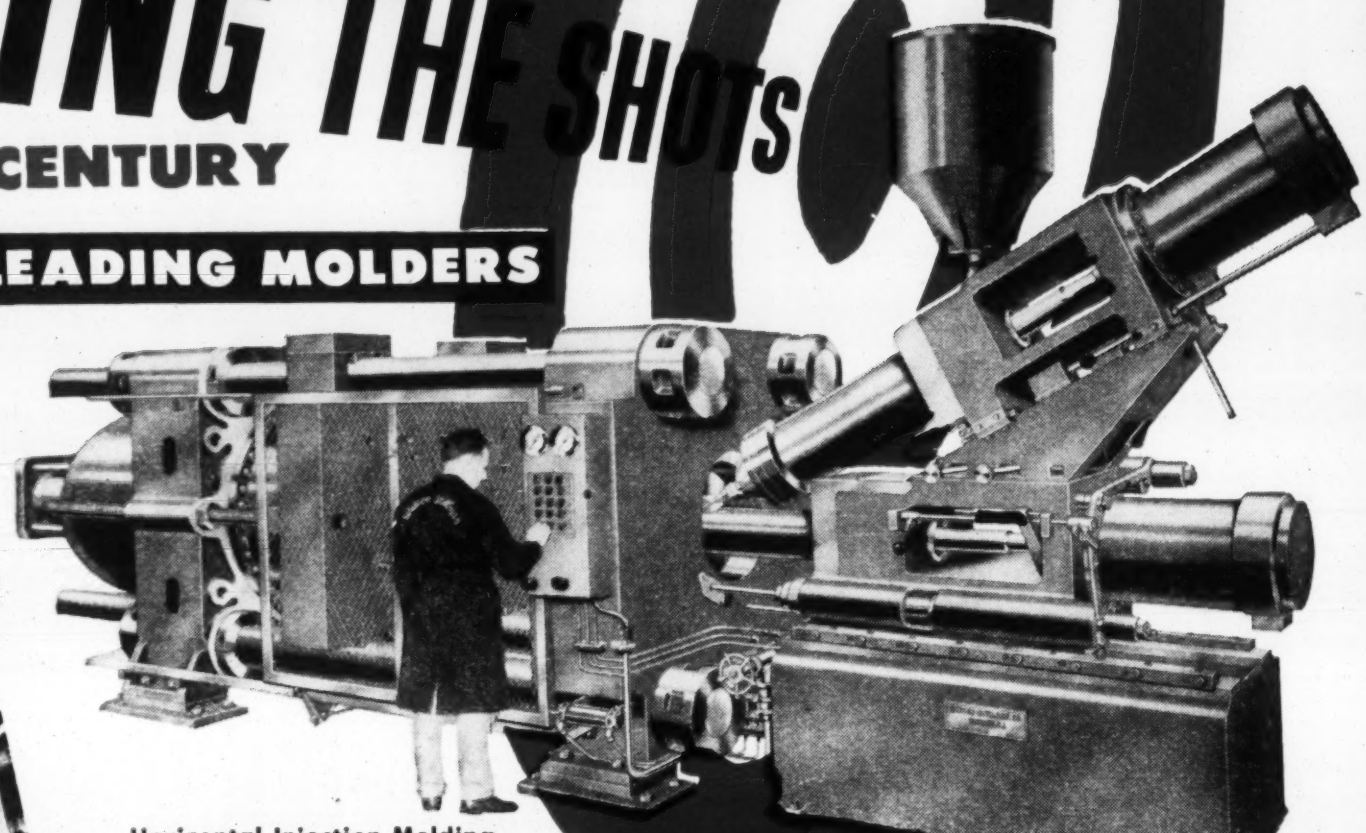
The sealer is designed to be universally adaptable and completely adjustable. It includes a set of eight adjustable car-

WATSON-STILLMAN HAS BEEN . . .

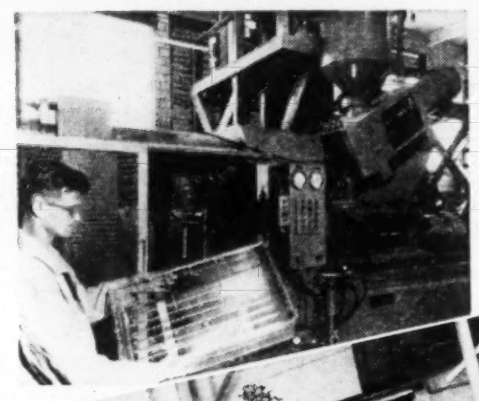
CALLING THE SHOTS

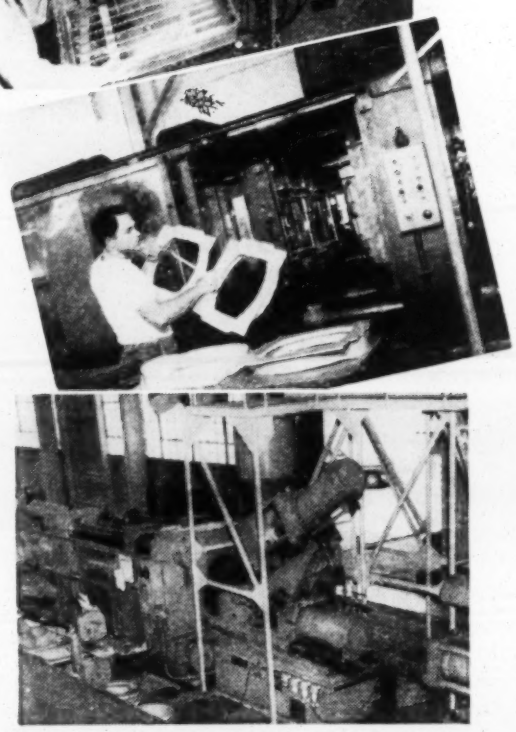
Over HALF A CENTURY

for the WORLD'S LEADING MOLDERS

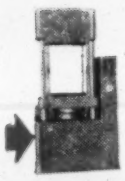


Horizontal Injection Molding Machines–12 to 300 Ounces



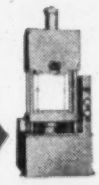


2 Ounce Semi-Automatic Injection Molding Machines.



Compression Molding Presses – 50 to 1200 Tons.

Vertical Injection Molding Machines – 1, 2, and 6 ounces.



Transfer Molding Machines–30 to 1200 Tons.

Growth and development of plastics molding as an *industry* has so impressively accelerated during the past few years that we are inclined to regard it as a youngster in *technique*.

Actually, most current "innovations" in plastics equipment are rooted in experimental work, going back more than 50 years to the days of celluloid collars and the first plastic billiard balls . . . the early pioneering days of Watson-Stillman research.

Throughout its 50 years of leadership in molding equipment manufacture, Watson-Stillman engineering has continued to "call the shots" on new materials, mold design, improved controls, and above all, on larger machine CAPACITY. For instance, the presently popular "new" trend toward increasing capacity by means of *preplasticizing* units was introduced by Watson-Stillman years ago . . . and has been successfully employed on Watson-Stillman units from 12 to 300 ounces capacity for years.

Today, as for more than 50 years past, it will pay you to consult Watson-Stillman *first* when you are molding by compression, transfer and injection techniques or when planning expansion or a new plant.

Branch Office:
228 N. LaSalle, Chicago, Ill.

W-S HYDRAULIC

Manufactured in Canada by
Canadian-Vickers, Ltd., Montreal

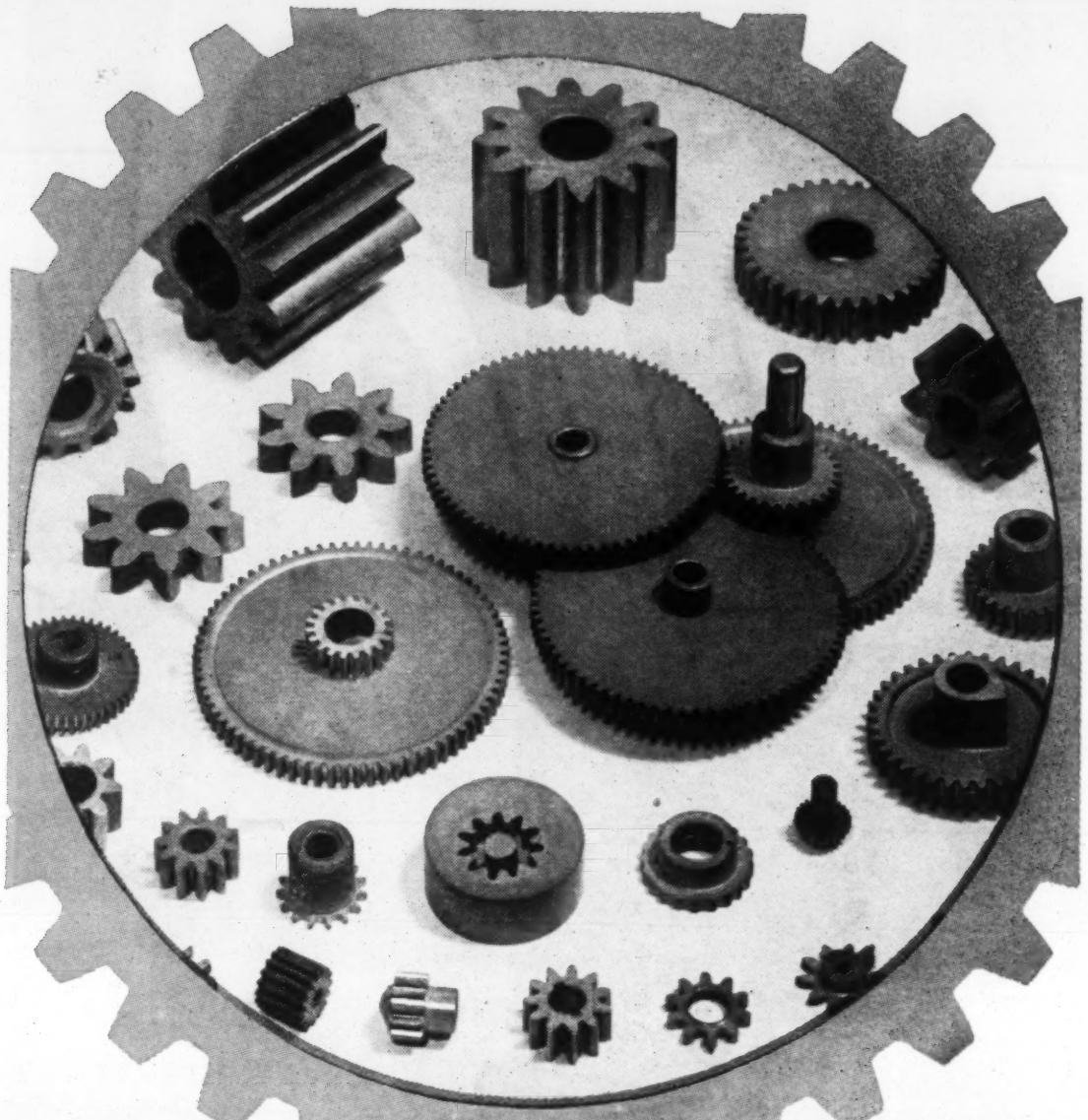
HYDRAULIC MACHINERY DIVISION
154 Aldene Road
ROSELLE, NEW JERSEY

WATSON-STILLMAN
ESTABLISHED 1848

Foreign Sales Representatives: OMNI PRODUCTS CORP., 460 Fourth Ave., New York 16, N. Y.
Correspondents Throughout the World

9-M-63

W-S "COMPLETELINE"—SHORTEST DISTANCE FROM PRODUCTION TO PROFIT



Exactly

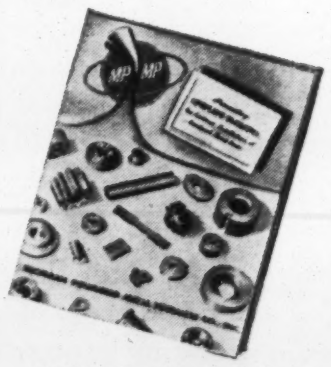
To Your Specifications . . .

GEARS of POWDERED METAL

Illustrated are but a few of the many types of gears which are being produced by Michigan Powdered Metal Products Company. Each has proved highly successful for its specific application . . . and each has made possible substantial savings in the cost of assembled finished products.

As one of the pioneers in the field of powder metallurgy, this company has been responsible for the development of many of the most advanced methods of producing powdered metal parts of all kinds. In the processes employed here, there is the most accurate control of density, porosity, dimensional tolerances and surface finish. When required, strength equivalent to that of mild steel can be provided—an important factor in gear production in particular.

If you need gears or other parts in high volume . . . if you're interested in the savings effected by elimination of machining and finishing operations . . . and if you want your specifications to be met *exactly*, it will pay you to learn what we can do for you. Send us your part prints for a quotation.



Write for this bulletin describing our facilities and the scope of our powdered metal parts production.

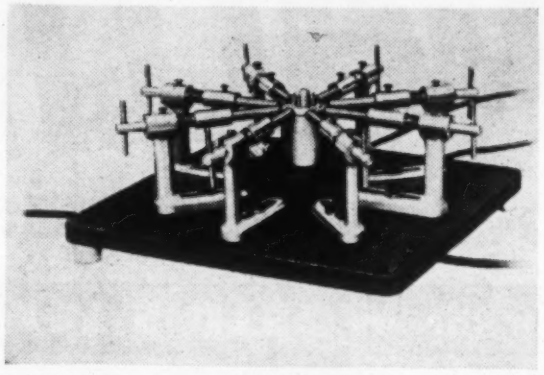
MICHIGAN POWDERED METAL PRODUCTS COMPANY, INC.

476 CADY STREET • NORTHVILLE, MICH.

Subsidiary of

ALLIED PRODUCTS CORPORATION

New Materials and Equipment



This can sealer is designed for use wherever soldered joints have to be made on cyclindrical, rectangular or tubular metal housings.

bon tip holders mounted on a plastic base, and is used for soldering enclosures up to 4 in. wide and 4 in. or more in height. The base is bored with a multi-hole pattern for various size and shape housing set-ups. The sturdy plastic base is easily drilled for unusual set-ups when necessary.

Metal Primer Dries Quickly for Re-Coating

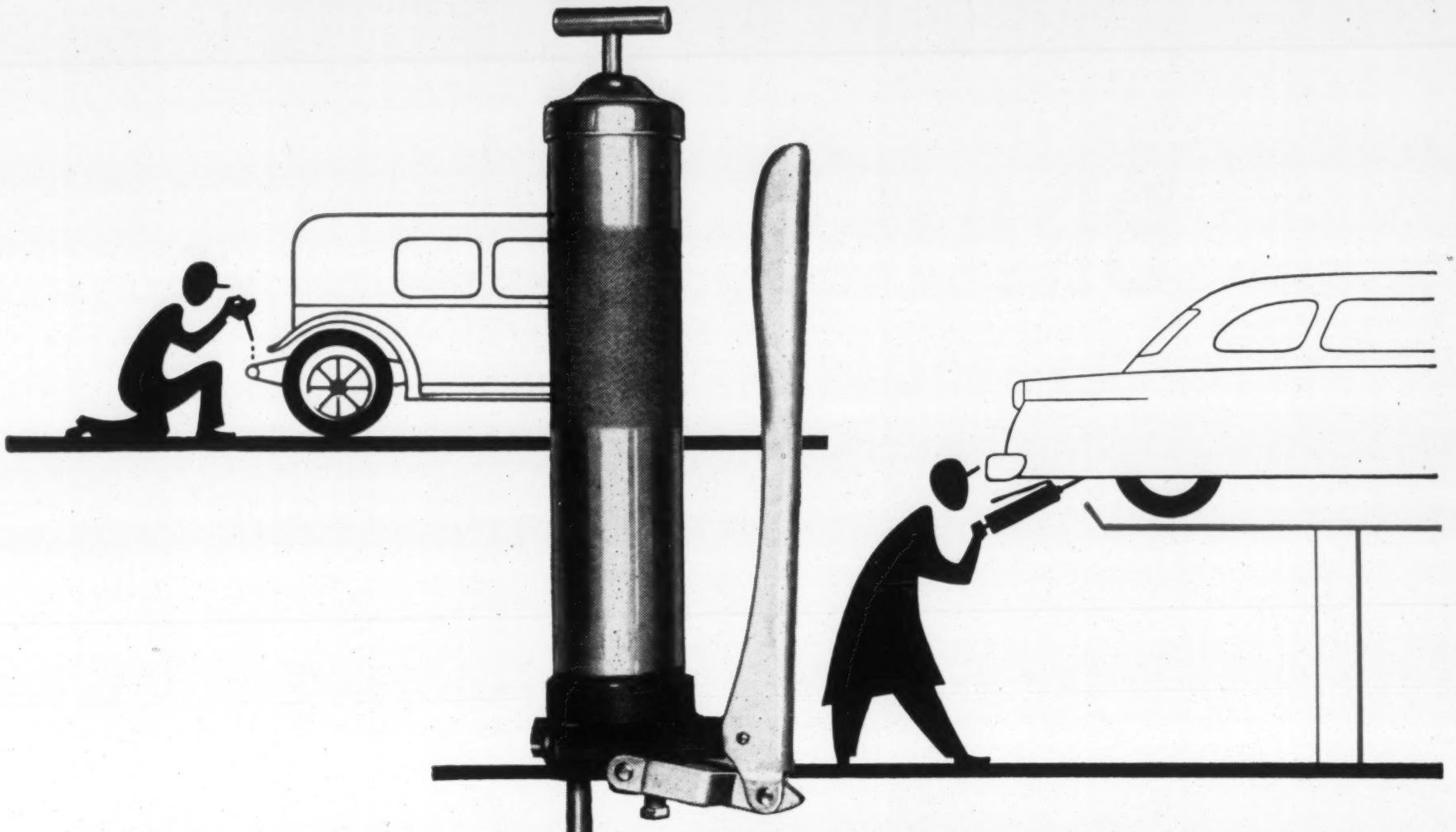
An iron oxide zinc chromate primer for steel and iron which can be re-coated with lacquer or any other finish coat within 3 min after application, has been announced by *Thompson & Co.*, Oakmont, Pa. According to the company, SP-3523H is exceptionally durable without a finish coat; under outdoor exposure it will protect ferrous metals for several months. However, it is a primer and should be protected with a finish coat.

The new primer has a satin flat finish and can be applied by spray, brush, flow coat or dip. Results of tests of a film thickness of 0.00075 in. on steel showed an ASTM salt spray resistance of 250 hr, 500-hr humidity resistance (100% relative humidity 100 F) and room temperature immersion in water 250 hr. The primer is said to dry in 10 min.

Slip Roll Forms 16-Gage Steel

A new, hand-operated slip roll which is said to form complete circles in 16-gage steel in one-third less the time it ordinarily takes and also form bends at any point in a sheet of material has been announced by *O'Neil-Irwin Manufactur-*

another case where welded steel tubing does the job best . . .



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helps make grease guns better . . .

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It's been years since a motorist had to squirt oil into the oil cups around his car before starting out for a spin.

Today every service station has a variety of powerful pressure grease guns that provide a longer-lasting, squeak-free lube job.

Most likely those guns are made from Republic ELECTRUNITE Welded Steel Tubing . . . light in weight . . . strong to stand rough service. Uniformity of dimension reduces costly machining, smoothness of ID reduces piston wear, helps hold high pressures. Uniformly good OD surfaces take and hold plated finishes, reduce rejection of plated parts after costly finishing has been done.

Service station operators prefer the long, trouble-free service that they get from gun barrels made of ELECTRUNITE Steel Tubing.

We like to tell manufacturers of all types of equipment how ELECTRUNITE Steel Tubing can help them make better products that cost less. May we tell you?

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STEEL AND TUBES DIVISION
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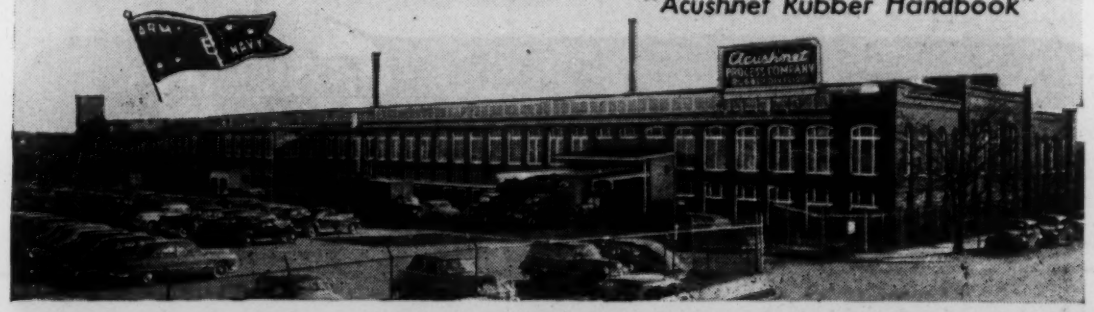
ACUSHNET accomplishments in this specialized field of precision-production are widely recognized throughout industry. We count among our customers many of the nation's leading manufacturers, as well as smaller producers of quality products.

Our Engineering Staff will gladly study your prints and recommend stocks with properties to meet specified conditions, or work with your engineers in the initial stages of their designs. Our staff is particularly adept in designing molds that provide maximum production efficiencies and economies.

Acushnet PROCESS COMPANY

Send for your copy of the "Acushnet Rubber Handbook"



Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

ing Co., Lake City, Minn. Designated Di-Acro Roller, the machine's exclusive feature is a cam actuated idler roll. Because of it, complete circles of 1-in. dia or larger can be formed in two passes through the rolls.

In 2-pass circle forming, the cam operating lever lowers the idler roll to allow insertion of the material. It also raises the roll to a pre-set position which determines the diameter of the circle to be formed. On the first pass through the roller, a half circle is formed, and on the second pass, the circle is completed. In addition, it was pointed out that parts can be duplicated with great accuracy and at a high rate of production since the idler roll always returns to its pre-set position.

Bends can also be located in any position along a sheet of material being formed in the roller as the material can be fed through the rolls without bending until the cam lever is engaged. As a result, a wide variety of shapes—with straight sections on both sides of the bend—can be produced.

Round, flat and square stock as well as many other ductile materials can be formed with this precision machine. Maximum material forming capacity of the roller is ¼-in. round steel bar and ¼-in. tubing . . . . . or their equivalents Special rolls will be supplied for special bending jobs.

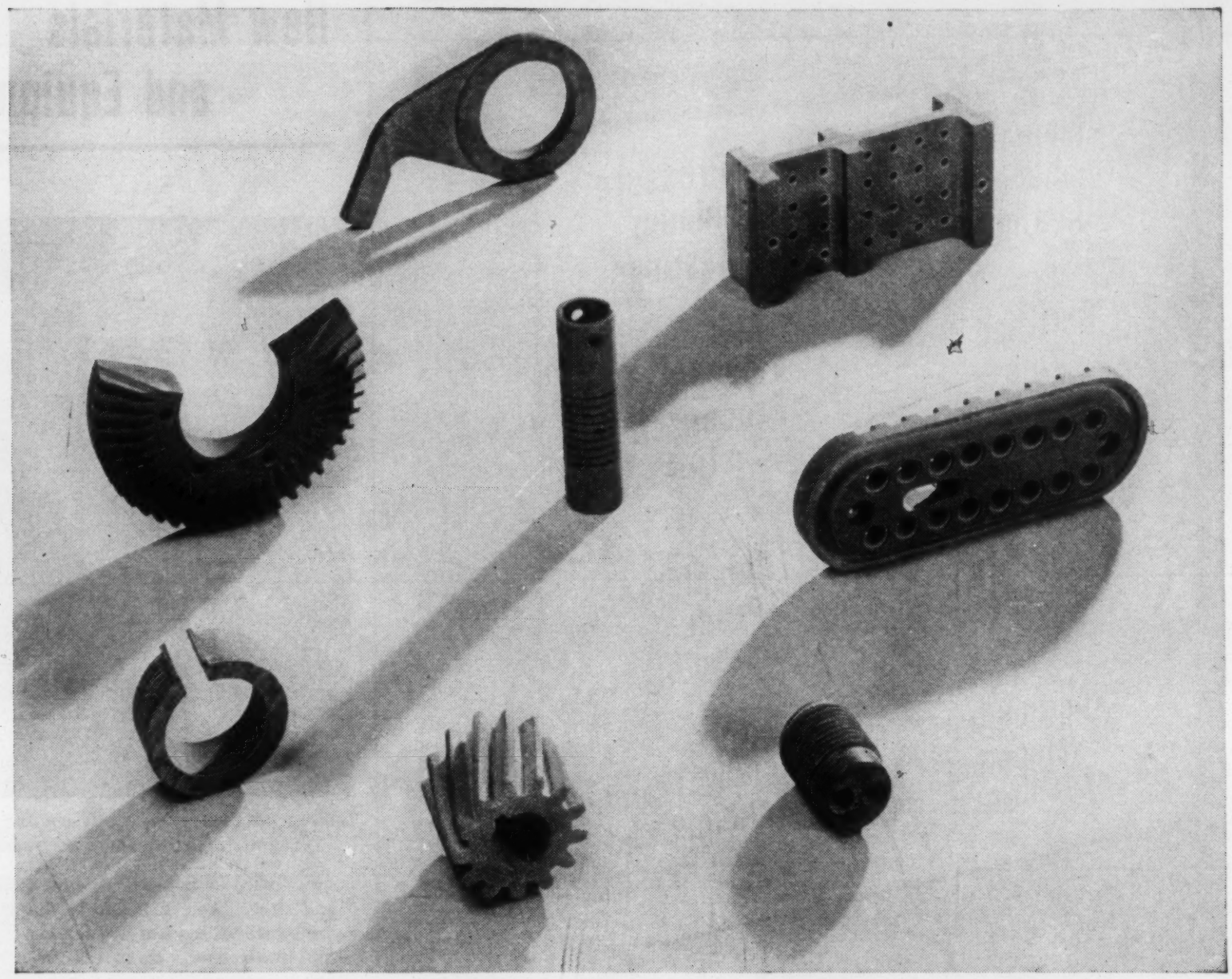
The roller is available in two sizes. No. 1 roller forms material up to 6 in. in width and No. 2 roller forms material up to 12 in. in width. Both will form material to a 1-in. dia or larger.

Aluminum Coating Provides Corrosion Resistant Film

A new industrial aluminum coating that can be sprayed without spattering objects or surfaces 4 ft or more in the background, is currently being offered by *Royston Laboratories, Inc.,* Blawnox, Pa. Because of the special vehicle and solvent selected for the formulation of the new coating, it is said to dry upon 4 ft of travel from the spray gun nozzle to a cottony, nonadhering powder.

In addition to this feature, Roylac is claimed to provide a superior and tightly bonded corrosion resistant film with a bright aluminum finish, particularly effective exposed to acid-type fumes and salt or moist air.

The material is plasticized to provide a film of good flexibility and bonding tack, effective for sealing wood or other porous surfaces. With its nonreactive vehicle, the coating is effective on galvaniz



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Would you like to replace hard-to-get materials with one that has served in many applications . . . is tough and rigid . . . light weight . . . corrosion resistant . . . and possesses other features such as high impact strength, low moisture absorption, and heat resistance?

LAMICOID, a thermosetting plastic laminate, is the answer. Made from fillers — such as glass, nylon, paper or fabric with various resins—this versatile material can be produced with just the properties you need. LAMICOID will not only serve as a replacement, but in many instances be an improvement, too.

LAMICOID is supplied in sheets, rods and tubes, or fabricated into parts as you desire. We'll be glad to put our 58 years of experience at your service and give you more details on how LAMICOID can help you replace critical materials. Write today for complete details or send blue prints and specifications for a prompt quotation.

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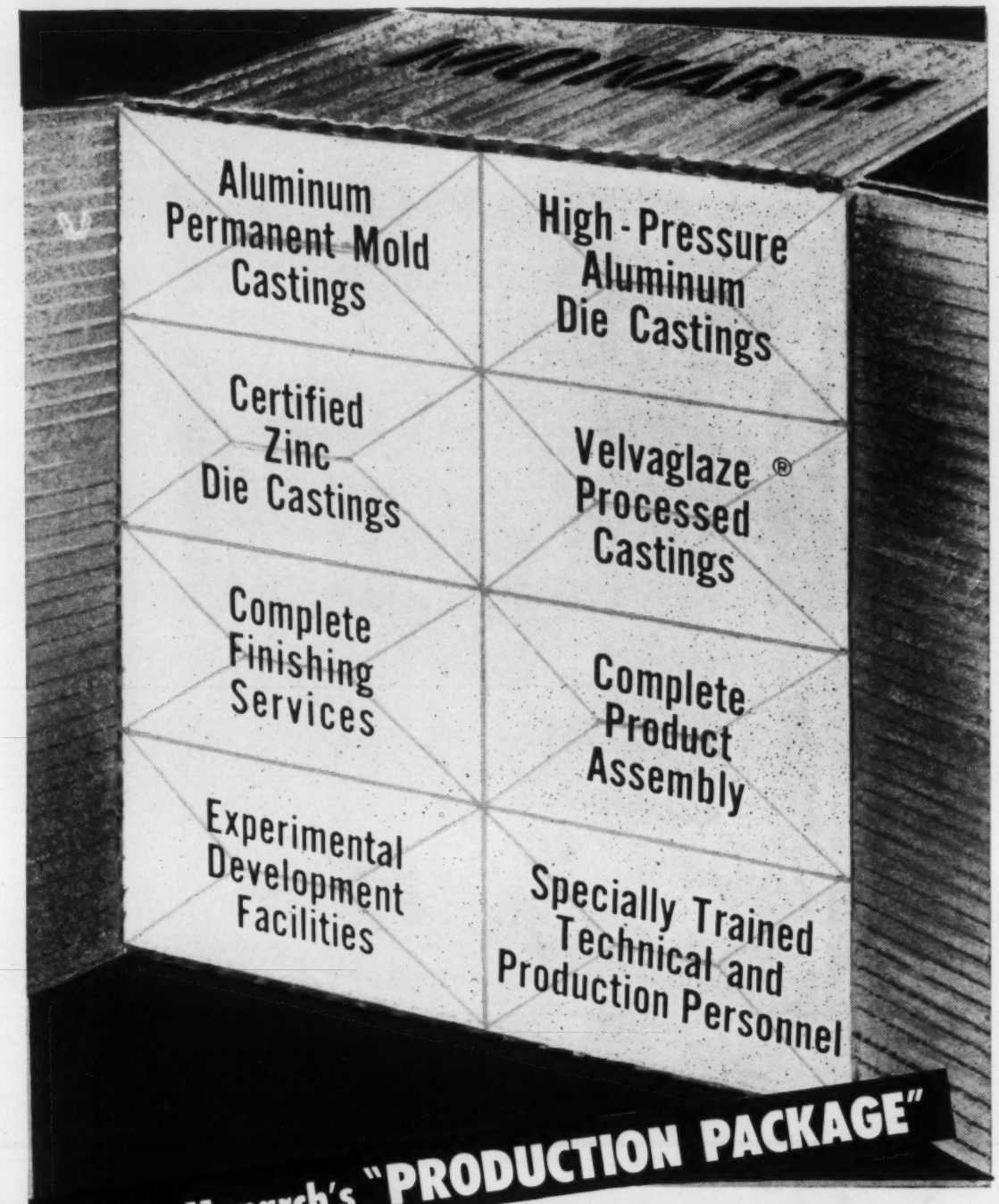

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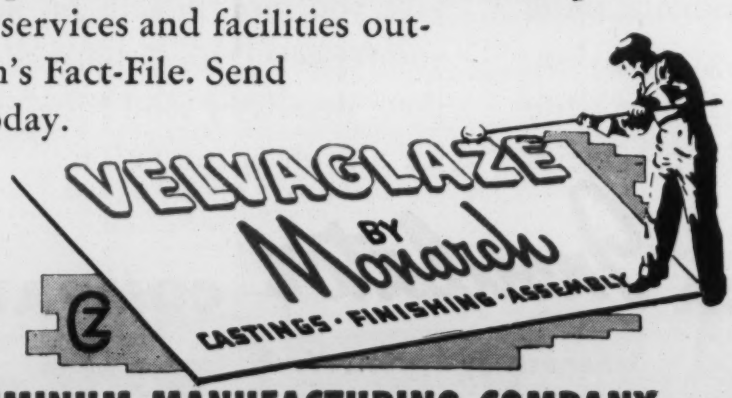
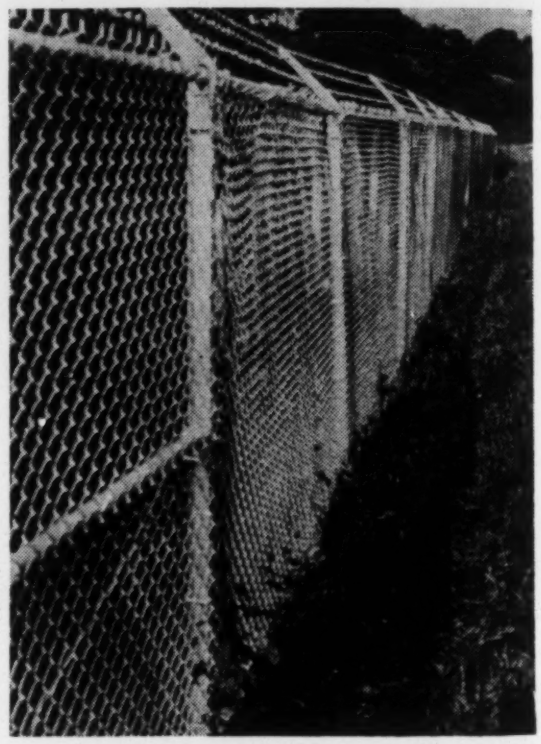
Contact your Monarch representative... discuss your problems and requirements for civilian or defense programs... use the services and facilities outlined in Monarch's Fact-File. Send for your copy today.



MONARCH ALUMINUM MANUFACTURING COMPANY

Detroit Avenue at West 93rd Street, Cleveland 2, Ohio

New Materials and Equipment



Note the absence of spray coating on the grass at the base of the fence.

ing, zinc, aluminum, magnesium, steel and other basic metals. It has been accepted as an economical, fast-drying product finish coat. It covers from 600 to 800 sq ft per gal and dries to a tack-free film in 12 min. The material is also easily applied by brush.

Stretch-Flattening Machine Developed for Precision Airframe Construction

Longren Aircraft Co., 2576 W. Carson St., Torrance, Calif., has announced the completion of a new (patent pending) stretch-flattening machine designed to process in volume integrally stiffened extruded skin sections and structures within the flatness tolerance requirements for precision airframe construction.

When aluminum alloy integrally stiffened extruded tubular sections are received in the Longren shops, they are first split longitudinally, roughly flattened, then heat treated. In flattening, the heat treated integrally stiffened sections are end-mounted between mechanical V-clamps in the tension flattening machine. One of the V-clamps remains fixed while the other is mounted on a hydraulic piston. Using hydraulic pressure, the entire sheet is then placed under tension to a point just below the yield strength of the material.

After initial tensioning, the traveling carriage with its three rigidly mounted

(Continued on page 159)

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Here's a good, dependable source for aluminum extrusions in quantity. Send us your inquiry with adequate information and we will answer promptly. Whatever aluminum shape you need for your product or contract, Youngstown Manufacturing, Inc., can supply. Write, wire or phone.

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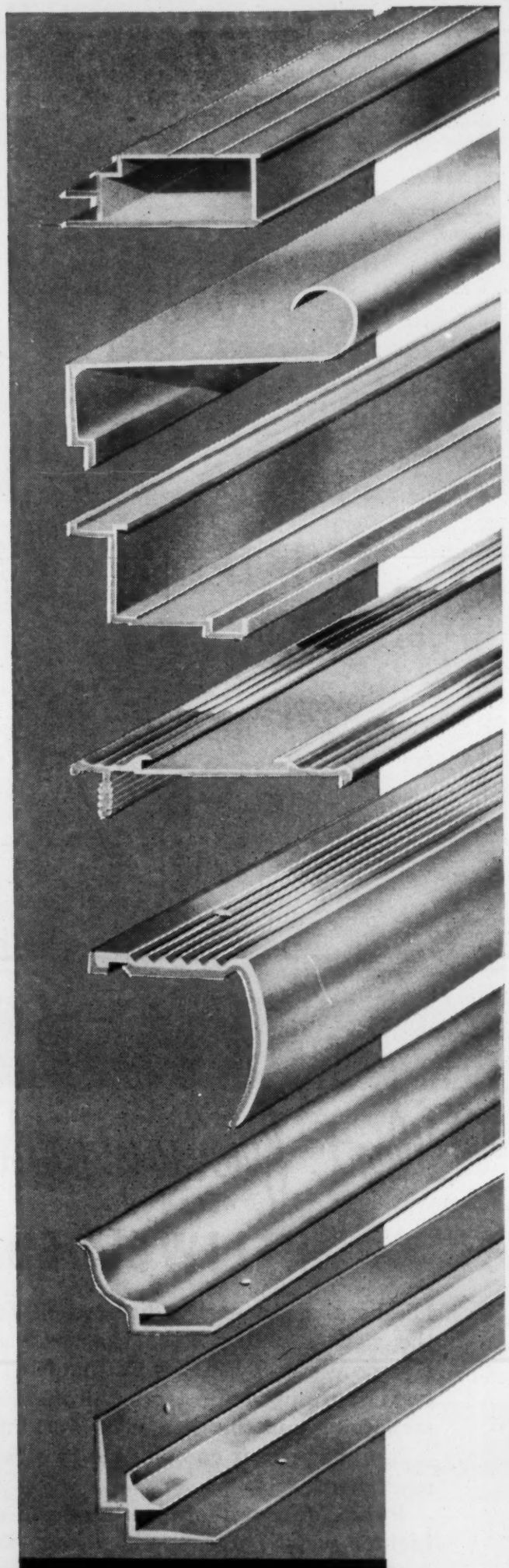


YOUNGSTOWN MANUFACTURING, INC.

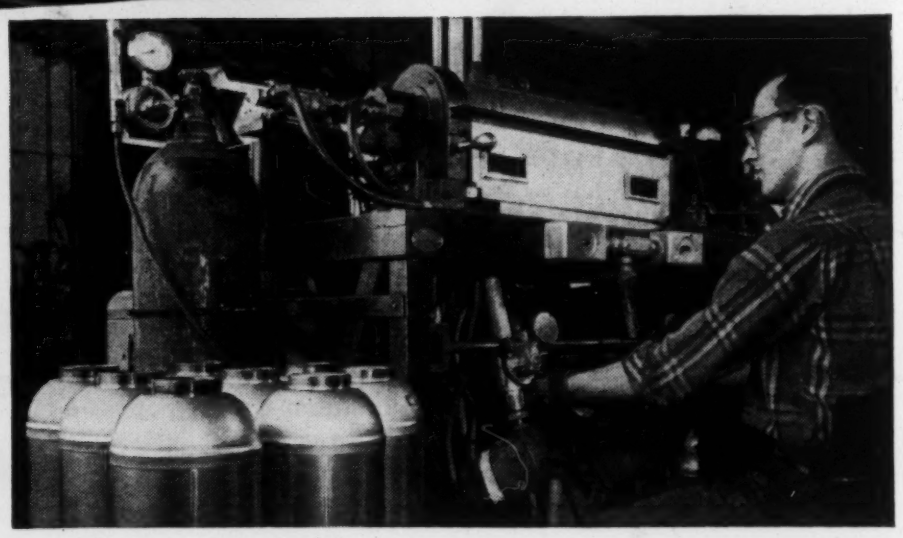
66-76 [illegible]
Youngstown 1, Ohio

SUPERIOR

500 psi hydrostatic pressure tests, 43% higher than usual test requirements, are standard procedure with Pyrene extinguishers before leaving the production line (high pressure tests of 1000 psi show no breakage).

Semi-automatic Heliwelding of type 301 stainless steel is a high-speed operation at the Pyrene Manufacturing Co. of Newark, N. J. Here, jig-mounted stainless steel cylinder bodies are longitudinally weld-seamed at 90" per minute.

Finger-tip controlling two No. 10 Radiagraph arms, one operator simultaneously Heliwelds two 1000 psi pressure-tested end seams in 41 seconds.



Silent fireman with a 40-foot reach...

HELIWELDED PYRENE FIRE-STOPPER

Discharging an easily directed 40-foot stream, the new stainless steel gas-cartridge-operated Pyrene Water Type Fire Extinguisher eliminates two important fire protection problems . . . annual recharging and the danger of working with acid . . . and its price is comparable to older soda-acid equipment.

Pyrene's answer for meeting the cost problem? Lighter weight equipment, stronger-made with Airco's semi-automatic Heliwelding process.

Why? Because Heliwelding, with its inert gas shield, eliminates the need for flux. No slag is formed, welds are exceptionally strong and clean. Gas shielded electrodes provide a highly concentrated arc permitting high-economy production welding with a minimum of distortion.

If you're welding thin sections of the "problem" metals, stainless steel, aluminum, on a production basis, Airco Heliwelding can help you. Find out how from your nearest Airco office. Please address Advertising Department, 60 East 42nd Street, New York 17, N. Y. for your copy of ADC-709: Heliwelding.

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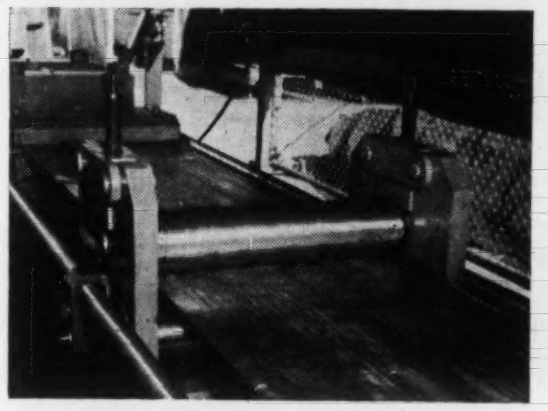
New Materials and Equipment



Roll stretch flattening in action is shown here.

displacement rolls is started along the sheet from the stationary jaw end. The movable chuck automatically takes up the slack of elongation and maintains even tension. The lower rolls of the carriage are sectional in design so that the tops of the extruded stiffeners rest firmly against an inner roll, while the outer rolls press firmly against the sheet area between the stiffeners. The upper roll is solid and smooth and presses against what will be the external side of the flattened section.

As the traveling carriage progresses along the sheet, the material feeds over the first lower roll, then angles slightly downward under the upper central roll. Beyond the upper center roll, it angles upward again, then reverts to the plane of tension between the end clamping jaws after leaving the last displacement roll.

Greatest elongation takes place as the material passes under the center roll; the material is tensioned slightly beyond its yield point, and work hardening takes place. On passing the last displacement roll, the material stabilizes to a permanently flattened condition.

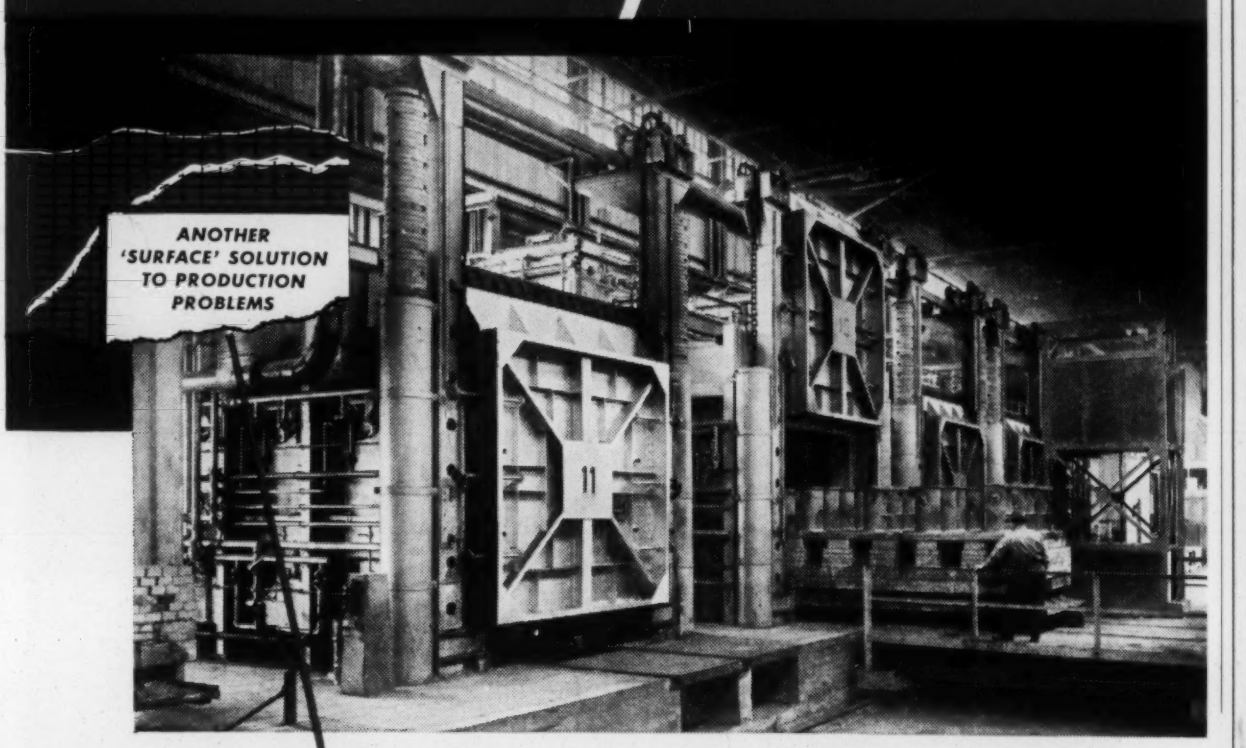
To further assure this passive condition, the angles of displacement through the rolls are carefully balanced out, thus assuring equal stress relief in both the sheet and the extruded stiffeners. After the sheets have been flattened to permissible tolerances, they can be contoured as desired using conventional stretch press equipment.

Wet Blast Machine Produces Refined Finishes on Production Tools

A new abrasive wet-blast machine for producing refined finishes on production tools is currently being offered by *Abrasive Wet-Blast, Inc.*, Niles, Ohio.

Special abrasives suspended in water, applied by air pressure, is the operational procedure, and it can be quickly taught

'Surface'



NORMALIZING armor castings in a 'Surface' car bottom direct-fired furnace with low pressure, velocity type burners.

***Direct-fired Furnaces may be your answer!**

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Annealing • Cycle Annealing
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For many heating and heat treating operations, where accurate control of temperature is the prime requirement, 'Surface' direct-fired furnaces often prove most economical.

Consider the flexibility of direct-fired equipment... An available temperature range of 600F to 2500F means you can draw, harden, anneal and forge... 70 types of 'Surface' burners in 700 sizes provide combustion equipment for your large and small production jobs. In addition, over 80 proved types of modern materials handling mechanisms are available for many important labor savings.

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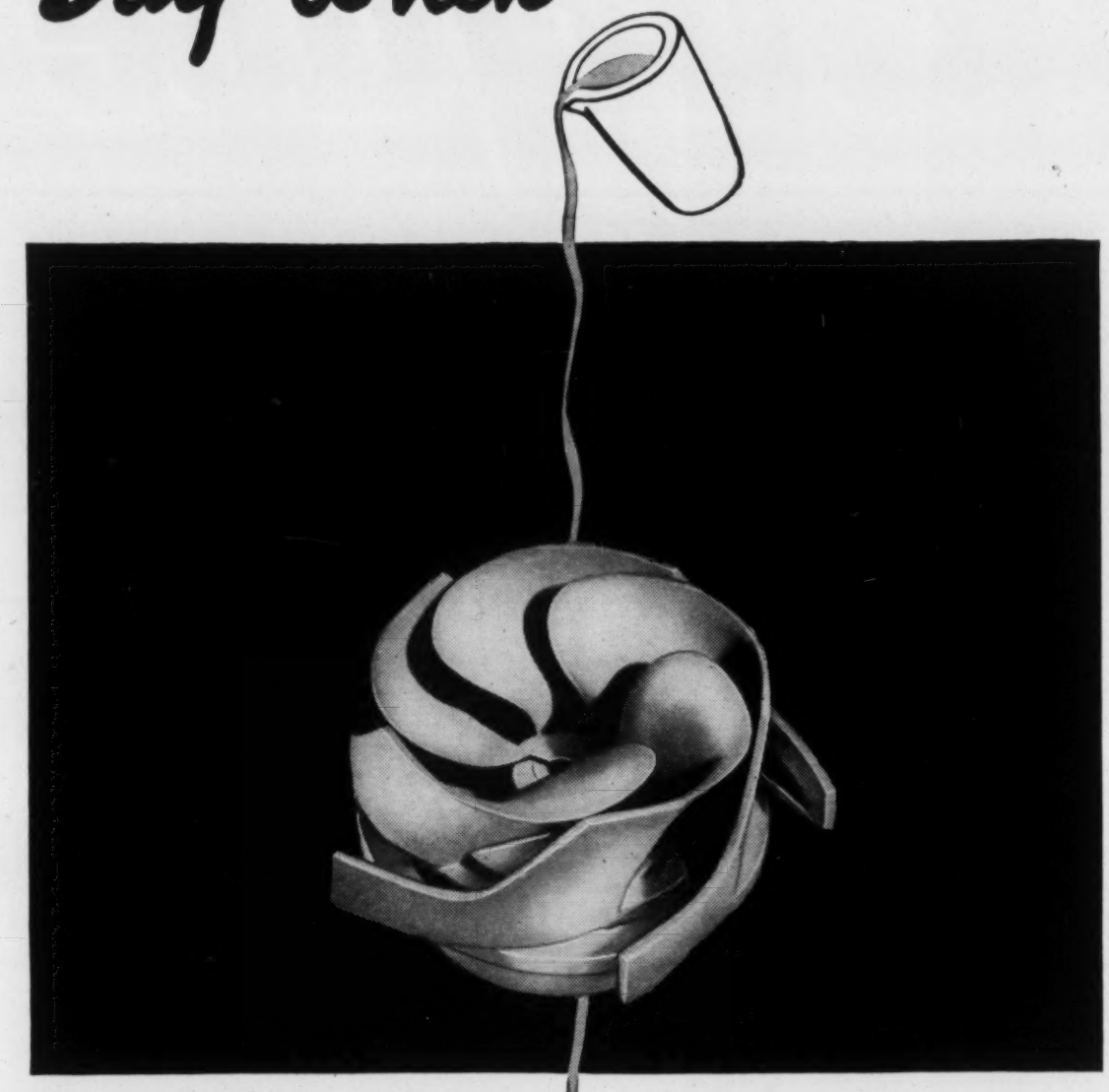
Say "when"



This part is an *Investment Casting*, made by the expendable pattern process. We mass produce it for $10.50. This kind of part can't be made in one piece by any other means—*at any price.*

Our Investment Castings frequently replace complicated assemblies. Often eliminate expensive pre-machining and finishing operations. Compromises in design are fewer because we cast in almost *any shape*—simple and complex—and in 160 different ferrous and nonferrous alloys.

Tolerances are extremely close; details are fine. Castings run from a fraction of an ounce to ten pounds.

Does this give you an idea?

Our engineers are skilled in designing parts as investment castings, as well as producing them. For a free copy of our book describing the tremendous possibilities of the process, write Precision Metalsmiths, Inc., 1077 E. 200th Street, Cleveland 17, Ohio.

when you think it can't be cast in one piece

when the service is too tough for die casting

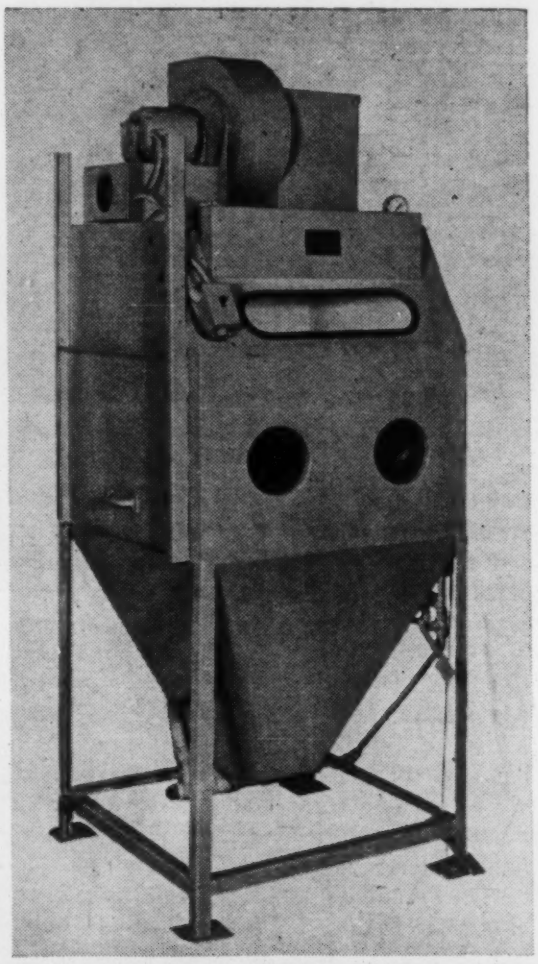
when it costs too much to machine

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

New Materials and Equipment



This abrasive wet-blaster prepares surfaces for bonding, painting and plating.

to any person on actual processing of parts. Metal removal is said to be negligible, retaining tolerances on accurately machined tooling, as the action of the process is to procure a refined finish on particular tools selected.

Form cutters, gear cutters, hobs, drawn dies—permanent die cast molds, extrusion dies, taps, etc., having this finish applied increase capillary attraction for lubricants, reduce friction, increasing tool life between grinds and giving greater production.

New Improved Vacuum Metallizing Equipment Offered

The use of high vacuum coating as a technique for producing metallic finishes has been stimulated both by metal shortages and the increasing familiarity and acceptance of the technique on the part of plastics and die casting finishers. *National Research Corp.,* 70 Memorial Dr., Cambridge, Mass., has introduced a new line of high vacuum coating equipment

JOHNSON BRONZE

SLEEVE BEARING DATA

Bearing TYPES

JOHNSON BRONZE

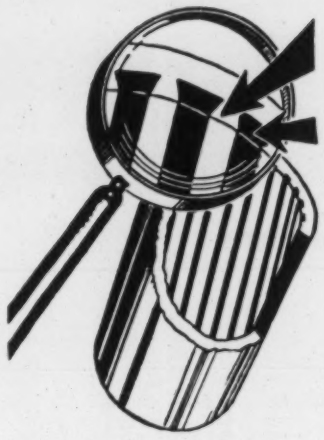
SLEEVE BEARING DATA

Graphited Bronze Bearings

GRAPHITED SLEEVE TYPE BEARINGS were developed primarily for applications where lubrication is difficult, likely to be neglected and where the speed of the shaft is too slow to sustain an oil film. They are also used in some applications where ordinary lubricants might damage goods or food products in process and where temperatures are too high for oil or grease.

There are three fundamental types available: cast bronze with serrated grooves, cast bronze with graphite plugs and bronze sheet metal with serrated, rectangular or diamond shape indentions.

In the cast bronze serrated type, minute, dovetailed grooves are cut into the bearing surface at a 7 degree lead. Graphite is then compressed into these serrations and remains permanently in place. This type provides from 40 to 45% graphite contact with the shaft which increases slightly with wear.



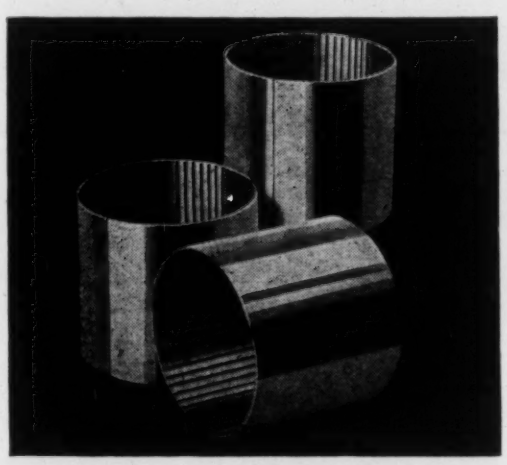
· · · Serrated type graphite bearing. Note the 7° lead and the dovetail shape of the serrations.

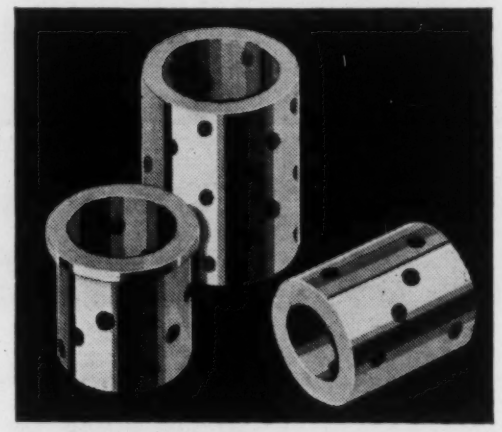
Plug type graphited bearings are produced by drilling holes of a suitable size in a cast bronze bearing on a staggered pattern through the wall. Stick graphite is then forced into these holes and remains permanently in place.

In some applications, ordinary oil grooves or combinations of oil grooves can serve as recesses to hold the graphite. It is also possible to compress graphite into grooving on the flange of cast bronze bearings when the application requires it.

The first step in producing bronze sheet metal graphited bearings is to cut serrations longitudinally into coiled strips of sheet bronze. The graphite is then forced into these serrations by a high pressure, patented process and baked under a carefully controlled temperature. The strip material is then blanked and formed into cylindrical shapes. In producing the cylindrical shape the serrations automatically become dovetailed which holds the graphite permanently in place.

Cast graphited bearings can be reamed in place, a maximum of 0.005 stock being removed. Sheet metal bearings *must* be burnished in place. The graphite used in Johnson bearings is not soluble in water, oil or gasoline. An occasional application of oil or grease where permissible will greatly increase the life of the bearing and lower the coefficient of friction. Cast graphited bearings are recommended for applications having slow speeds and minimum loads. For intermittent service or oscillating motion we recommend sheet metal with graphite. Quantity is a factor also and in large production runs of any given size, sheet metal is surprisingly low in cost.





Ledaloyl Bearings

While graphited bearings are sometimes referred to as "Self-Lubricating" Johnson Bronze produces another type by powder metallurgy known as *Ledaloyl*. This bearing is low in cost, high in efficiency and holds up to 35% oil by volume. It is particularly economical when produced as a self-aligning, flanged or other odd shaped part as there is no machining required. Write for complete details.

› Limiting Factors For Successful Performance

1-Speed—Load Factors:

(a) For constant running shafts—PV=18,000# in (min.) sq. in. proj. area.

(b) For constant running shafts (with supplementary lubrication) PV=120,000# in (min.) sq. in.

(c) For Oscillating shafts—PV=60,000# in (min.) sq. in.

(d) Intermittent service—PV=120,000# to 250,000# in (min.) sq. in. (use safety factor)

2-Bearing Pressures:

(a) All graphite jobs (without additional lubrication) 40 to 50# sq. in. (for speeds of 30 ft. per min.)

(b) With supplementary lubrication 350# sq. in.

3-Temperatures:

(a) Standard graphited bushings—Satisfactory up to 250° F. 275° F. (Using conventional leaded bronzes and serrated type.)

(b) For temperatures up to 400° F. Conventional leaded bronzes with graphite plugs.

(c) For temperatures—Up to 1000° F. Special lead bronze alloys with graphite plugs. At higher loads, oil should be used in conjunction with the graphite plugs for higher efficiency.

4-Running Clearances:

(a) Constant running shafts—50% higher than standard.

(b) Oscillating shaft—Standard allowance can be used.

5-Wall Thickness:

Minimum thick.
1/16" for O.D. up to 1".
Minimum thick. Serrated type
3/32" for O.D. over 1".

Max. wall thick.—Optional to designer. For plug type graphite—wall to be same as diameter of graphite plug—⅛ min.

6- Graphited bushings should be recommended for speeds less than 30 ft. per min. for at such low speeds it is impossible to develop film pressure necessary to prevent metallic contact.

7-Stock Allowance for finishing

(a) It is necessary to finish bushing in assembly. Reaming stock allowance of not more than 0.005 should be allowed for cast bronze graphited.

(b) At least 0.004 stock for burnishing sheet metal graphited.

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
769 S. MILL ST. • NEW CASTLE, PENNA.

Insist on Prest-O-Lite
Trade-Mark

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The term "Prest-O-Lite" is a trade-mark of Union Carbide and Carbon Corporation.

Linde Air Products Company
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to meet the current demands for higher production and lower costs.

A large tank coater, 5½ ft in dia, is said to offer definite advantages in that the size of the load can be increased, and larger pieces can be handled. There is no sacrifice in cycle time, since this equipment is supplied with pumping systems which will provide even faster cycles than those experienced in the past with the smaller 4-ft dia tanks.

A variety of pumping systems are offered which can be tailored to suit the customer's requirements. The system currently offered for maximum production consists of two 16-in. diffusion pumps, two 16-in. booster pumps, and a 200 CFM mechanical roughing pump. The large tank can be pumped to coating pressures in less than 5 min with this pumping system under ideal conditions. Performance of the system when working against heavy outgassing is said to be equally good.

Silicone-Base Aluminum Paint Withstands Temperatures to 1700 F

An extra high heat resisting silicone-base aluminum paint, which is said to fuse with the metal on which it is applied and to withstand temperatures up to 1700 F, has been announced by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9. H-170 makes possible the effective painting of many types of industrial equipment which have previously been regarded as unpaintable due to temperature limitations.

Like standard Heat-Rem, H-170 is claimed not only to resist heat, rust and corrosion, but to greatly improve the general appearance of surfaces on which it is applied. The paint's specially formulated, free-flowing vehicle (with silicone base) insures maximum spreading capacity and great durability.

Heat-Rem H-170 should be applied to any hot metal interior or exterior surface with temperatures ranging up to 1700 F. Unlike ordinary high heat paints which will not dry on unheated surfaces, this paint will air dry in approximately 30 min without heat. However, paint surface will be relatively tender, and full, hard drying will not be achieved until heat is applied.

Easily adapted to spraying, dipping or brushing, depending upon the dictates of the job, the paint provides a bright, long wearing, protective finish which will not peel or flake off.

Experimental model made of Vibrin polyester resins and glass fibers by Glasspar Company, Costa Mesa, California

What would happen if somebody made...

an auto body of plastic?

Plenty—and all of it good! Look what happened when they made an all-plastic body of Naugatuck Vibrin polyester resin and glass fiber laminates.

No more wrinkled fenders! You just can't dent this car! After an impact that would crumple any ordinary fender or door, this amazing material springs right back to its original shape! It's unharmed except by the heaviest of impacts.*

No more rusting! Rain, snow, salt sea air, even the worst of weather won't harm this body.

Easy to make—easy to repair! Custom-built Vibrin car bodies are formed with a few large moldings—without pressure or heat—at a fraction of former toolage costs! And they are quickly and simply repaired in case of damage.

In fact, this Vibrin body is so light (no more than 200 lbs.) and simple in construction, it may be easily removed for major repairs to motor or chassis. Its lighter weight can mean reduced gas consumption and increased tire life, too!

Manufacturers, what do you want to make? Easy to see there's a worldful of profitable possibilities in Naugatuck Chemical's new Vibrin polyester resin. From figurines to limousines, it's constantly turning up new and better ways to new and better products. Find out what this unusual, news-making plastic can do for you. Send us the coupon below.

*Deliberately driven into a tree twice at 15 mph, a test model suffered only a 14-inch crack at the point of impact! The crack was repaired within an hour!

Naugatuck Chemical

Division of **UNITED STATES RUBBER COMPANY** • Naugatuck, Conn.

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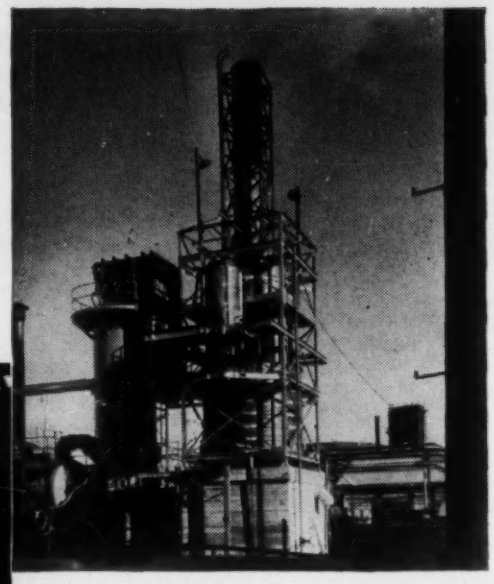
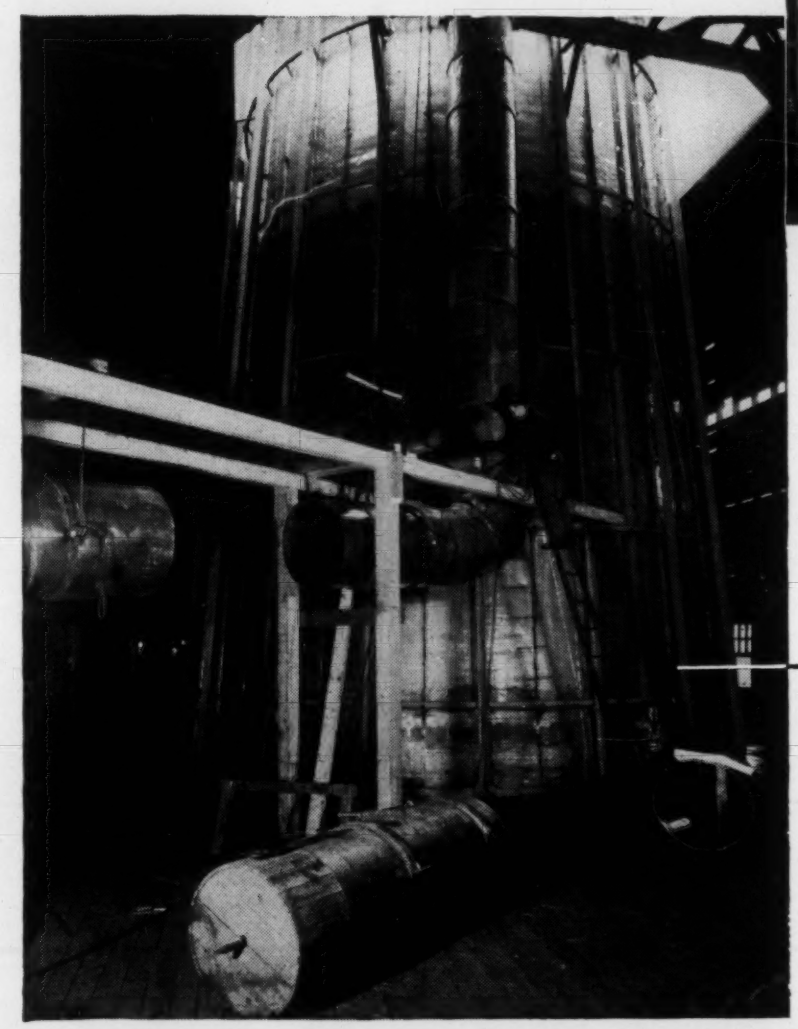
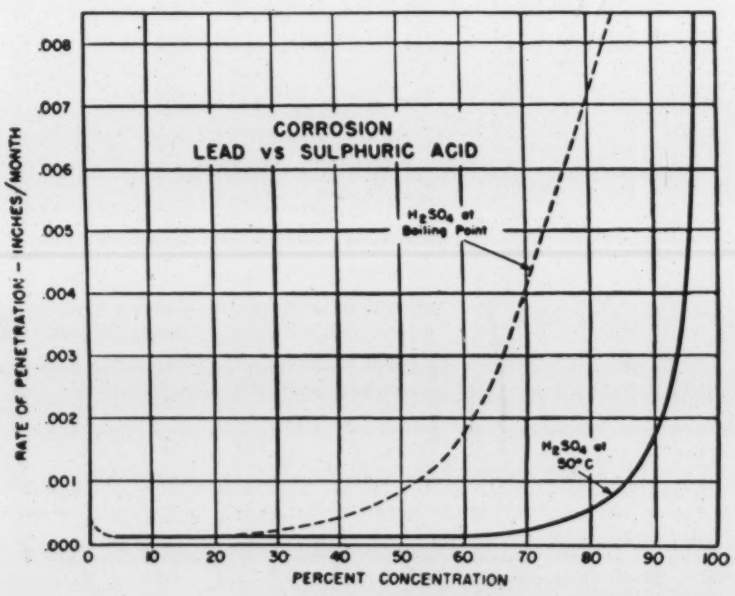
Mills-Packard towers used in the manufacture of sulfuric acid by the chamber process are constructed entirely of sheet lead supported in a steel frame. The lead is cooled externally by water flowing down the sloping sides.





Electrostatic precipitator of the type used throughout the oil refining and chemical industries to prevent air pollution by sulfuric acid mist. Lead construction throughout, supported in steel framework.



Courtesy: LEAD INDUSTRIES ASSOCIATION

for handling corrosive chemicals **lead** is basic

Lead, known in the middle ages as a *base* metal, to set it apart from the noble metals, is regarded in fact as a *basic* metal in the modern age. In the chemical process industries, indeed, lead has proved virtually indispensable. Of all the common metals, lead is the most corrosion-resistant in contact with industry's most-used chemicals—especially sulfuric acid, the principal chemical of the vast process industries. Lead has the unique property of forming automatically upon its surface a protective coating of insoluble and tightly adherent lead salts, thus setting up an effective barrier that prevents further corrosion of the metal.

While lead is unusually resistant to corrosion, it also is unusually receptive to manipulation, so to speak. Rolled in sheets, lead is readily formed to make linings for tanks and all manner of vessels for the handling of acids. Extruded in tubular form, or cast in molds or dies, lead makes pipe, coils and innumerable other items for use with corrosive solutions. Furthermore, lead, as a material of construction, is "manageable" in the field and on the job. Lead is inseparably joined by a simple "burning" or welding process without further heat treating or annealing. The adaptability of the metal is also a distinct advantage in meeting unexpected on-site conditions. Finally, of all the common materials used for chemical construction, lead is the most easily salvaged and a higher proportion of it is salvageable.

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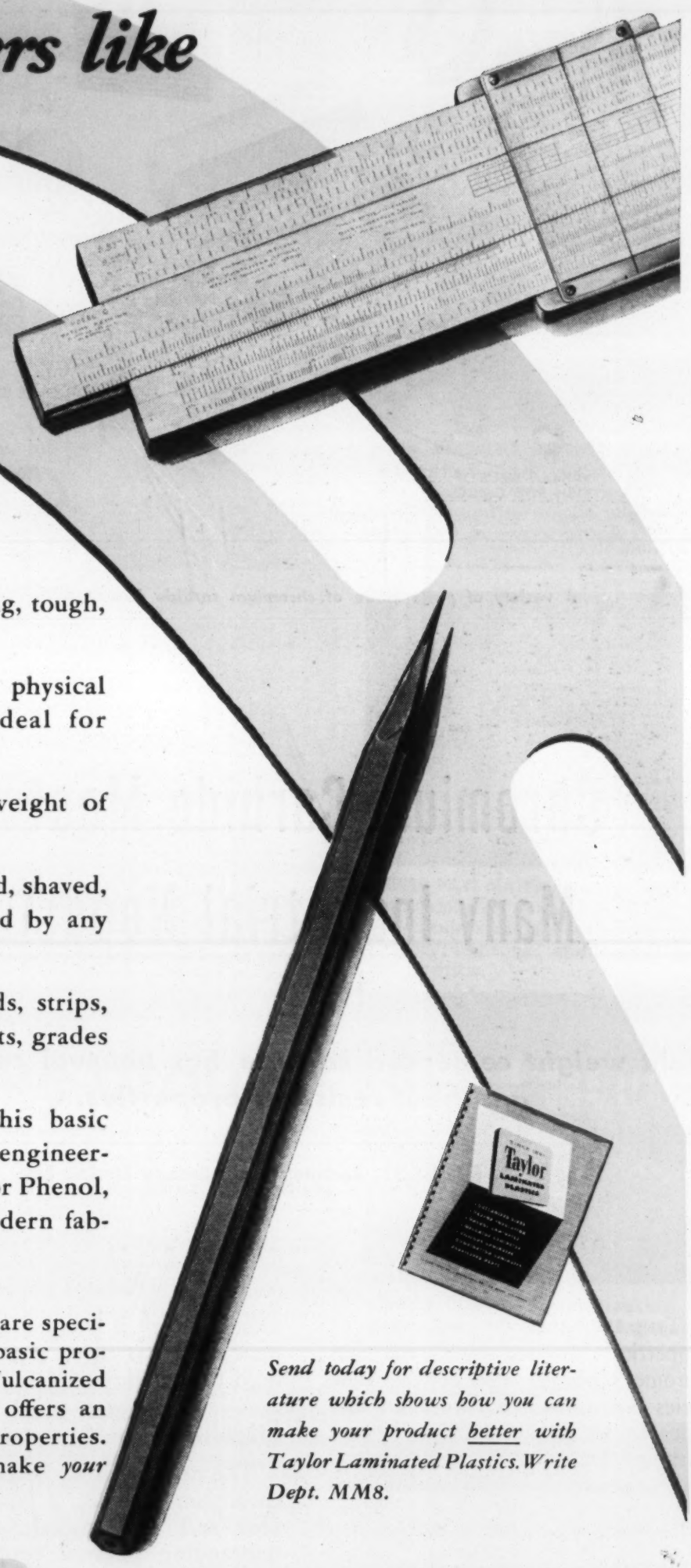

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. . . it's light in weight (about one-half the weight of aluminum) . . . low in cost.

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. . . it's available in a wide range of sheets, rods, strips, rolls and other forms . . . in many colors, weights, grades and sizes.

Why not explore the possibilities of using this basic material in *your product* now? Write for complete engineering data. Ask, too, about Taylor Insulation, Taylor Phenol, Silicone and Melamine Laminates, and our modern fabricating facilities.

All over the world...

. . . more and more design engineers are specifying *Taylor* Vulcanized Fibre as a basic production material—because Taylor Vulcanized Fibre is tough, wear-resistant, and offers an unusual *combination* of insulating properties. How can this versatile material make *your* product better?

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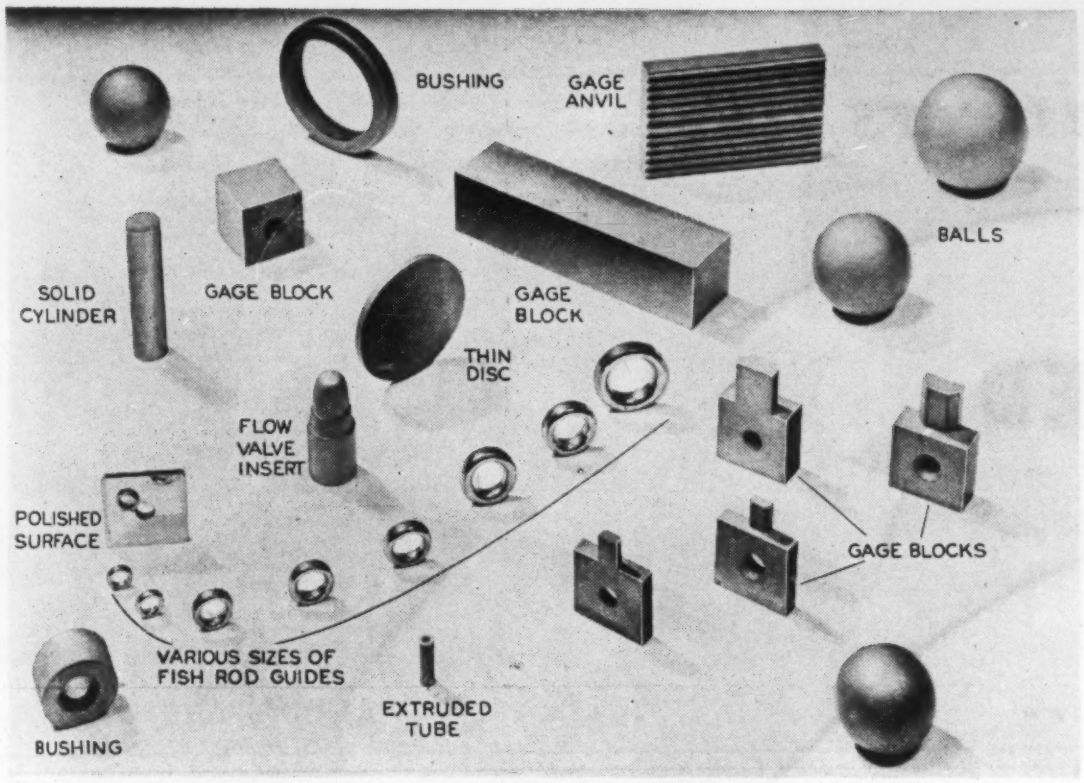

A variety of parts made of chromium carbide (Grade 608).

Chromium Carbide Meets Many Industrial Needs

Light weight cemented carbide has unusual corrosion and heat resistant properties.

by J. D. KENNEDY, Carboloy Dept., General Electric Co.

● THE UNUSUAL COMBINATION of properties exhibited by Grade 608 Chrome Carbide, first of the new Series 600 cemented chromium carbides to be made available by the Carboloy Dept. of General Electric Co., is expected to lead to wide application of the new group of materials. Many preliminary successful applications have already been made. These broad applications demonstrate the extent to which chromium carbides can be used by industry.

Grade 608 Chrome Carbide has extremely high resistance to both corrosion and erosion, and has good abrasion resistance, too. Made by the powder metallurgy process, this metal is light weight, has a coefficient of thermal expansion approximately the same as steel, is completely nonmagnetic, and has extreme resistance to high temperature oxidation.

Properties

The new metal is composed of 83 chromium carbide, 2 tungsten carbide and 15% nickel. Among its outstanding physical properties are its density, which is about half that of tungsten carbide, and its coefficient of thermal expansion, which approximates that of steel. Actually, tungsten carbide has a thermal expansion coefficient about half that of steel. It is a hard, strong metal and resists abrasion much better than hardened steel.

(Continued on page 168)

ATLANTA, Ga., Alpine 4885
Morrison-Drabner Steel Co., Inc.

BALTIMORE, Md., Peabody 7300
Hill-Chase Steel Company of Maryland
Asheboro, N.C.: Phone 8849
Richmond, Va.: Phone 7-4573

BEAUMONT, Tex., Phone 4-2641
Standard Brass & Mfg. Co.

CHICAGO METROPOLITAN AREA
Korhumel Steel & Aluminum Company
Evanston, Ill.: Ambassador 2-6700

CINCINNATI, Ohio, Wabash 4480, 4481
Morrison-Drabner Steel Co., Inc.

CLEVELAND, Ohio
Nottingham Steel Company
Atlantic 1-5100
Copper & Brass Sales, Inc.
Endicott 1-6757

DALLAS, Tex.
Delta Metals, Inc.
Hunter 7446
Earle M. Jorgensen Co.
Riverside 1761

DAVENPORT, Iowa, Phone 3-1895
Nichols Wire & Aluminum Co.

DETROIT, Mich.
Copper & Brass Sales, Inc.
Lorain 7-3380

HONOLULU, T. H., Phone 5-2541
Permanente Cement Co.

HOUSTON, Tex.
Standard Brass & Mfg. Co.
Preston 1123
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Riley 9311
Korhumel Steel & Aluminum Company
Franklin 5361

KANSAS CITY, Mo., Victor 1041
Industrial Metals, Inc.

LOS ANGELES, Calif.
Eureka Metal Supply Company
Mutual 7286
Earle M. Jorgensen Co.
Lucas 0281
Reliance Steel Company
Adams 6133

MILWAUKEE, Wis., Evergreen 4-6000
Korhumel Steel & Aluminum Corp.
of Wisconsin

MINNEAPOLIS, Minn.,
Korhumel Steel & Aluminum Company
Gladstone 5943, Prior 4030

NEW ORLEANS, La.
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Raymond 2116
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New York: Chelsea 3-4455
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OAKLAND, Calif.
Gilmore Steel & Supply Company
Glencourt 1-1680
Earle M. Jorgensen Co.
Higate 4-2030

OMAHA, Nebr., Atlantic 1830
Gate City Steel Works

ORLANDO, Fla., Phone 7124
Profile Supply Company

PHILADELPHIA, Penna., Delaware 6-5400
Hill-Chase & Company, Inc.
Allentown: Allentown 28077
York: York 5790

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Arizona Hardware Co., Inc.

PITTSBURGH, Penna., Hemlock 1-5803
Follansbee Metal Warehouses

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PORTLAND, Ore., Tuxedo 5201
Eagle Metals Inc. of Oregon

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Gilmore Steel & Supply Company

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Eagle Metals Company

SHREVEPORT, La., Phone 2-9483
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Eagle Metals Company

ST. LOUIS, Mo., Lucas 0051-2-3
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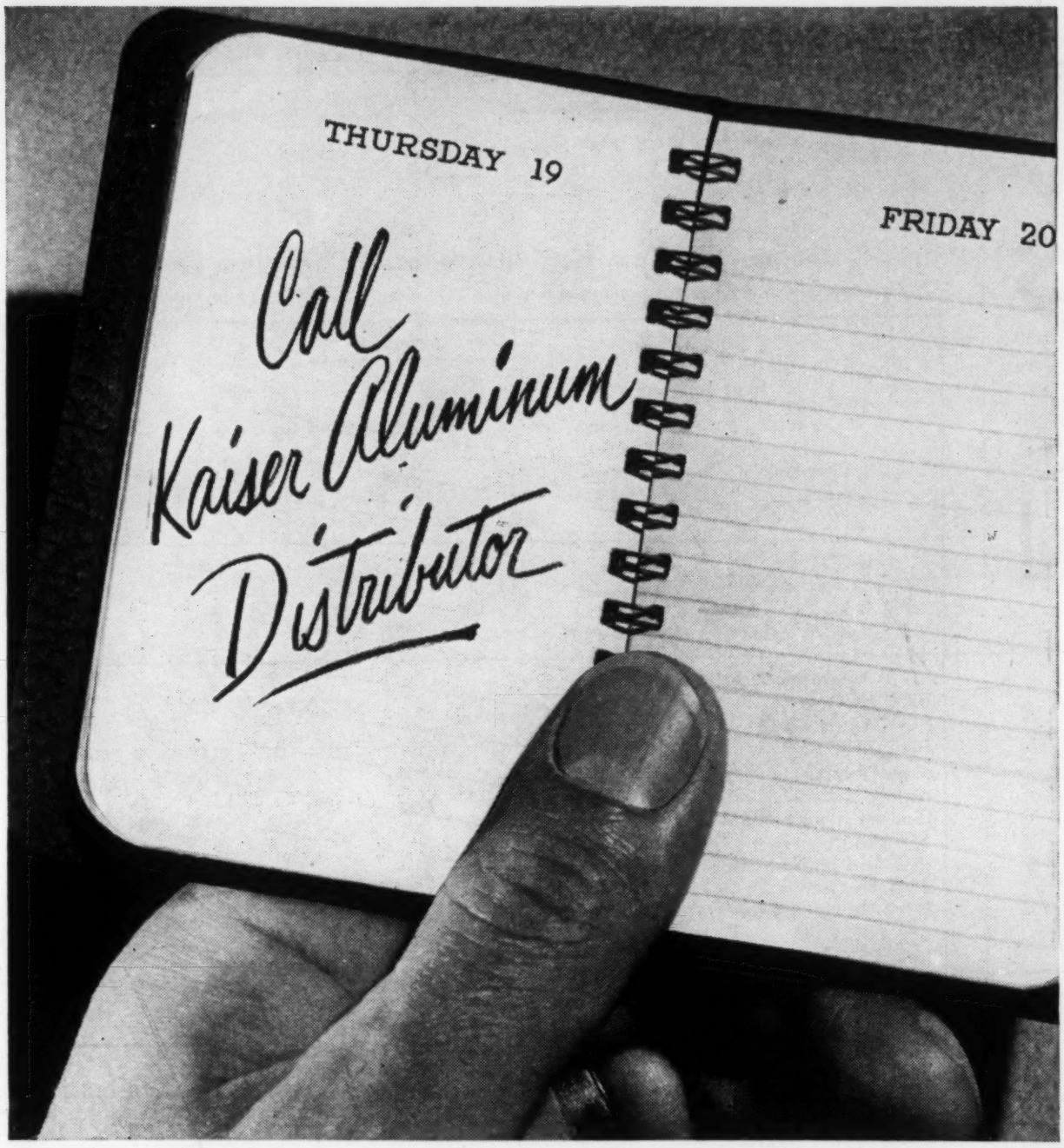


A good man to have around

WHEN you consider the *many services* your nearby Kaiser Aluminum Distributor offers you, it's clear why he's a good man to have around, whether the aluminum market is tight or soft.

He catalogs and stocks a large variety of aluminum forms—anticipates your needs so accurately that you get them with the least possible delay.

He gives you the advantage of his specialized knowledge on each of the items he stocks—helps you select the aluminum that's best for your particular job.

He studies new methods to help you stretch available aluminum supplies; furnishes experimental quantities; meets emergency needs.

He keeps abreast of ever-changing government requirements—often can supply the information necessary to help you obtain government orders and the aluminum to fill them.

And because Kaiser Aluminum is building facilities which will increase its production of primary aluminum 137%, your Kaiser Aluminum Distributor may, sooner than you think, be able to increase your share.

It will pay you to visit your Kaiser Aluminum Distributor often.

◀ Your nearest Kaiser Aluminum Distributor is listed at the left. Call him TODAY!

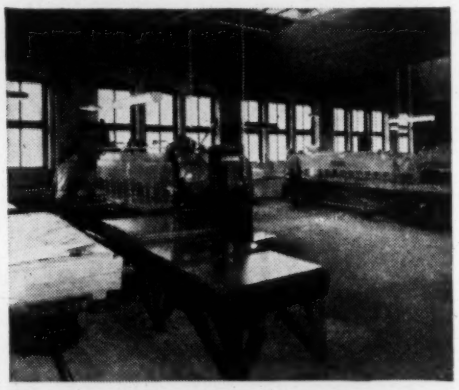
Kaiser Aluminum

Setting the pace—through quality and service

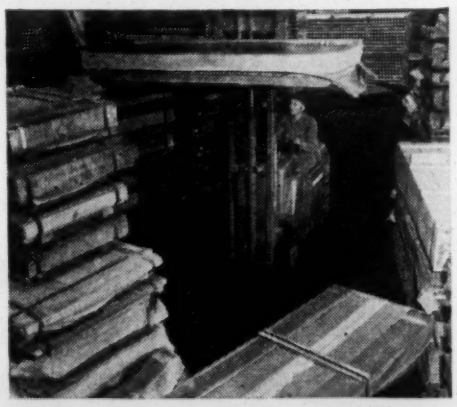
HERE'S HOW YOUR DISTRIBUTOR HELPS YOU:

MORE VERSATILE INVENTORY—Warehouse stocks give you the opportunity to select from a complete range of alloys and form, slit, sheared, or sawed to fit every production demand.

LOWER RAW MATERIAL INVESTMENT—Daily delivery eliminates tying up your dollars in idle or obsolete inventory; improves your current capital position.



LOWER COSTS—Specialization of warehouse plant and handling equipment permits deliveries at lower cost at machine side, cuts stock keeping and accounting costs.



SMALLER SPACE REQUIREMENTS—Space necessary to house your average raw material inventory can be devoted to production. Becomes a source of income rather than an expense.

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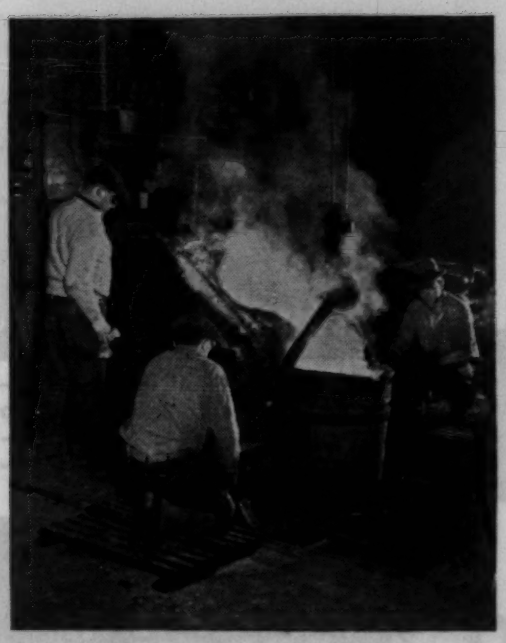
Castings
in Stainless and Special Alloys...
require Control in Melting



Arc or induction melting at Lebanon Steel Foundry is an exacting process, for a heat must duplicate *precisely* the material composition required. Electric melting is but one of many production procedures rigidly followed by Lebanon craftsmen that result in CIRCLE Ⓛ castings of *controlled* high quality.

LEBANON STEEL FOUNDRY
Lebanon, Pennsylvania
"In the Lebanon Valley"

CIRCLE L LEBANON Steel and Alloy Steel Castings

Chromium Carbide . . . .

continued from page 166

Comparative Corrosion Resistance of Chromium Carbide

(Loss in weight in mg per sq decimeter per day. Average of 10- to 24-hr immersion periods)

Chemical	Results				
	Series 600 Chromium Carbides	Other Cemented Carbides			18:8 Stainless Steel
		WC+Co	WC+TaC +TiC+Co	WC+TaC +Co	
10% H_2SO_4 (10% Sulfuric Acid)	55	158	302	135	1650
50% H_2SO_4 (50% Sulfuric Acid)	31	100	120	81	7300
37% HCl (37% Hydrochloric Acid)	190	600	650	160	Total Loss
35% HNO (35% Nitric Acid)	19	250	330	110	45
HNO_3-HCl (Aqua Regia)	810	2820	4500	1550	Total Loss
NaBCl 0.07 Cl_2 PH 9 (Sodium Hypochloride)	100	230	1000	158	11
5% NaOH (5% Sodium Hydroxide)	0.6	22	7	12	1.0
50% NaOH (50% Sodium Hydroxide)	1.0	3	3	4	2.0
5% $CaCl_2$ (5% Calcium Chloride)	0.3	41	24	27	1.3
1.0% Citric Acid	0.6	176	150	160	2.0
5.0% Lactic Acid	1.5	200	170	255	5.1

Salt spray tests conducted at Battelle Memorial Institute reveal that chromium carbides retain their metallic lustre after being subjected to a 30% salt spray for 750 hr. When subjected to sulfuric acid corrosion tests, Series 600 chromium carbides show 30 times the resistance of 18:8 stainless steels and three times the resistance of conventional carbides. Resistance of chromium carbides to nitric acid is eight times that of other carbides and twice that of 18:8 stainless steel. They are also inert when exposed to citric and lactic acids. Results of actual chemical tests for corrosion resistance of Series 600 chromium carbides are shown in the accompanying table.

Chromium carbides resist oxidation at all temperatures up to 1832 F. When subjected to a temperature of 1850 F for 24 hr, samples of chromium carbide are only slightly discolored, while simultaneously exposed samples of stainless steel and tungsten carbide have completely disintegrated.

Steam erosion tests show a resistance for chromium carbides about 50 times that of conventional carbides. Samples 1½ in. in dia and 0.250 in. thick were placed ½ in. in front of a 350-psi jet of saturated steam passing through a 1/16-in. dia nozzle for 25-hr periods. Four tests of 25 hr each made with different but identical nozzle assemblies show no measurable erosion penetration on the chromium carbide samples after the first three tests. Maximum average penetration after the first 100 hr is 0.004 in. These tests show that Series 600 chromium carbides are equivalent to other metals, with maximum resistance to steam erosion.

Available Sizes and Shapes

Grade 608 Chromium Carbide is already available in limited quantities in a variety of shapes for engineering and metallurgical test applications. Production facilities are being expanded to permit delivery of production lots soon. When production facilities are completed, the new carbide will be available in approximately the same size and shape range in which tungsten carbide is now being offered.

Because costly and critical tungsten and cobalt are not constituents of Grade 608 Chrome Carbide, it is expected that complete parts can be economically made of solid chromium carbide in contrast to attaching individual pieces, as has been done with tungsten carbide in the past. The light weight of chromium

(Continued on page 170)

No trick to this, with ROCKRITE TUBING!

Three steel parts in place of two. That's a feat worth doing these steel-conscious days. But it's no trick with Rockrite Tubing, sized by a distinctively different process to closer tolerances than possible with any other method. Rockrite Tubing can give you: • 50% more parts per pound of your steel allotment because more of the metal goes into the finished part. • Up to double the output of parts from each automatic screw machine. • A corresponding reduction in the total cost of the finished part, including tube stock and machining.

ROCKRITE® TUBING

TR132A

Learn more about how close-tolerance Rockrite Tubing can step up your production, step down your steel requirements for quantity production of ring-shaped and cylindrical parts. Bulletin R2 tells the full metal-saving story. Write for your copy today.

Rockrite saves more than any other tubing

- *Higher cutting speeds*
- *Tools last longer between grinds*
- *Work-surface finishes are better*
- *Machined parts have closer tolerances*
- *Stations on automatics are often released for additional operations*
- *Extra-long pieces available—less downtime for magazine stocking and fewer scrap ends*
- *Closer tolerances often eliminate necessity for machining on outside or inside*

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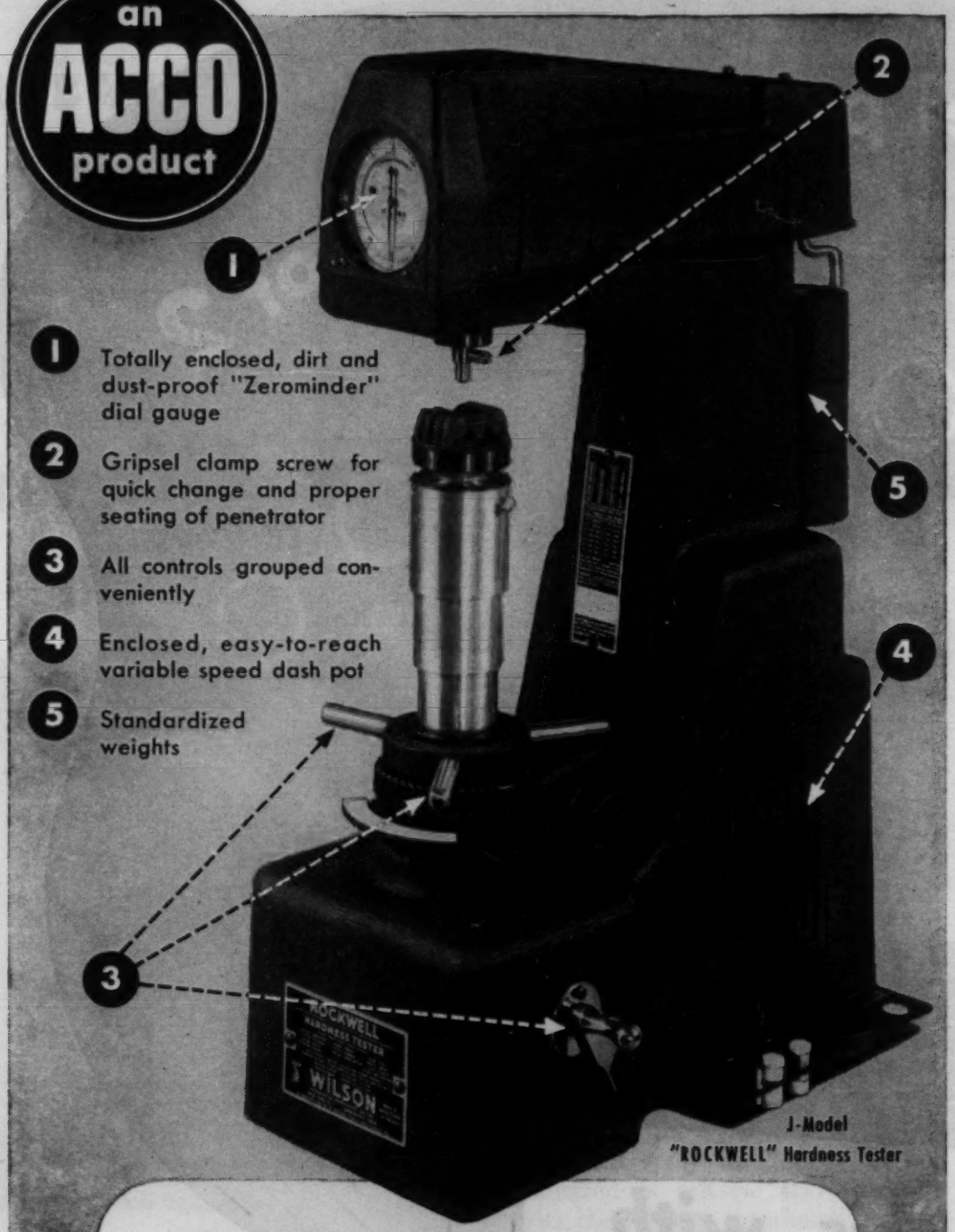

1 Totally enclosed, dirt and dust-proof "Zerominder" dial gauge

2 Gripsel clamp screw for quick change and proper seating of penetrator

3 All controls grouped conveniently

4 Enclosed, easy-to-reach variable speed dash pot

5 Standardized weights

J-Model "ROCKWELL" Hardness Tester

5 Important "ROCKWELL"* Features

You can be *sure* of the hardness of incoming metals and the various parts or products you ship to your customers if you use a WILSON "ROCKWELL" Hardness Tester. Only in the WILSON will you find these five important features which assure accuracy and ease of operation.

There are two types of WILSON "ROCKWELL" Hardness Testers . . . Regular and Superficial. They come in many styles with accessories for testing flats, rods, rounds, and odd shapes. For micro-indentation hardness testing, there is the WILSON TUKON.

Write for information and let us make recommendations.

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230-E Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and TUKON Hardness Testers

Chromium Carbide . . . .

Continued from page 168

carbide is another factor in favor of this design concept.

Methods of Fabricating, Finishing and Attaching

Generally the same methods used in fabricating tungsten carbide are used for Grade 608 Chrome Carbide. Components can be molded to shape for standard or quantity parts. They can also be economically machined to required shapes in the presintered condition for small lot production. Grinding, lapping and polishing of chromium carbide is performed with conventional silicon carbide grinding wheels, diamond grinding wheels and diamond lapping compounds. Polished surfaces of chromium carbide have a more brilliant lustre than those of tungsten carbide.

Physical Properties of Cemented Chromium Carbide (Grade 608)

Hardness	88 Rockwell A
Density	7.0 gm per cu cm
Transverse Rupture Strength	100,000 psi
Coef. of Thermal Expansion	6.4×10^{-6} in range of 70–1292 F

Grade 608 Chrome Carbide can be joined by brazing, by mechanical means, or by thermosetting resin cements. It is necessary to flash plate chromium carbide parts with nickel for brazing with conventional materials.

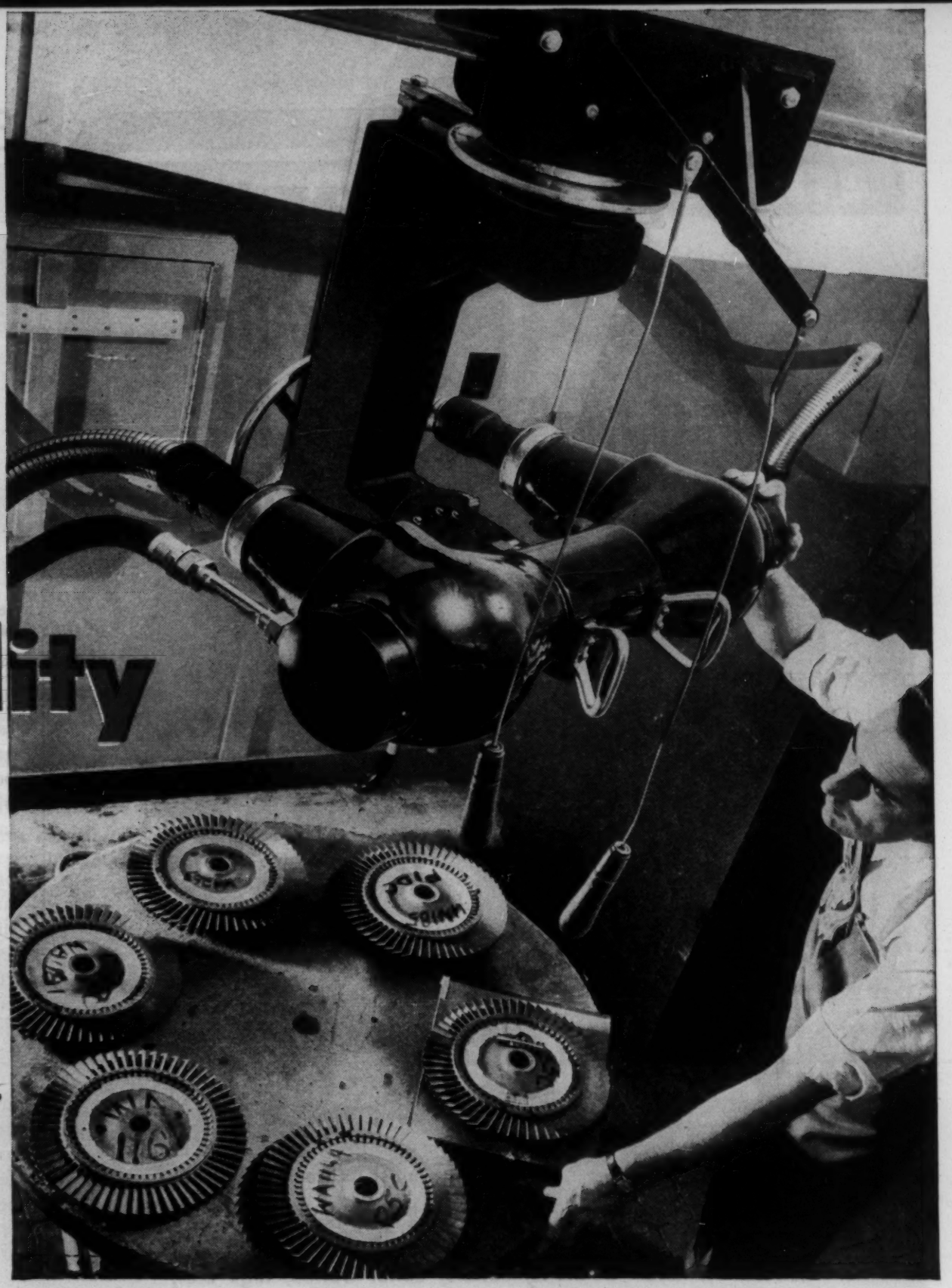
The results of recent tests with ethoxyline resins as a bonding agent for attaching chromium carbide to nonporous materials like metals have been very encouraging. Bond strengths of the ethoxyline resin cemented joints at room temperature are much lower than brazed joints but approximately equal to those of soft soldered joints. In general, resin-cemented joints can be used in place of brazed joints where high strengths are not required and when the application operates at room or slightly elevated temperatures.

To use ethoxyline resin cemented joints successfully, the surfaces of the carbide and metal must be clean.

(Continued on page 172)

Full X-Ray Flexibility

assured for all-purpose inspection



Westinghouse 250 KV
JIB CRANE
X-RAY UNIT

Curtiss-Wright uses Westinghouse X-ray equipment for non-destructive testing of the important parts of their outstanding aircraft engines. The application pictured here shows the 250 KV X-ray tubehead, mounted on the jib crane tubestand, being positioned for the examination of the critical welds on gas turbine booster rotors.

The keynote for the selection of this equipment was *flexibility*—since *flexibility* results in more radiographs per shift.

1 Since the kilovoltage can be varied from 30-250 KV with greater X-ray output per KV resulting from the constant potential high voltage supply, the unit can be used to inspect materials from under ⅛" aluminum to 4" of steel.

2 The jib crane tubestand carries the tubehead from less than 3' up to 9' above the floor and from 50" to 141½' from the center of the vertical column which, in turn, can be rotated 135° in each direction. The tubehead mounting permits rotation of 180°, in either direction, around a vertical axis, and 140° around the long axis of the tubehead. The X-ray tube can be positioned easily and quickly to radiograph parts ranging in size from very small to very large.

Call your Westinghouse representative, or write to Westinghouse Electric Corporation, Industrial X-ray Section, 2519 Wilkens Avenue, Baltimore 3, Maryland.

J-08263

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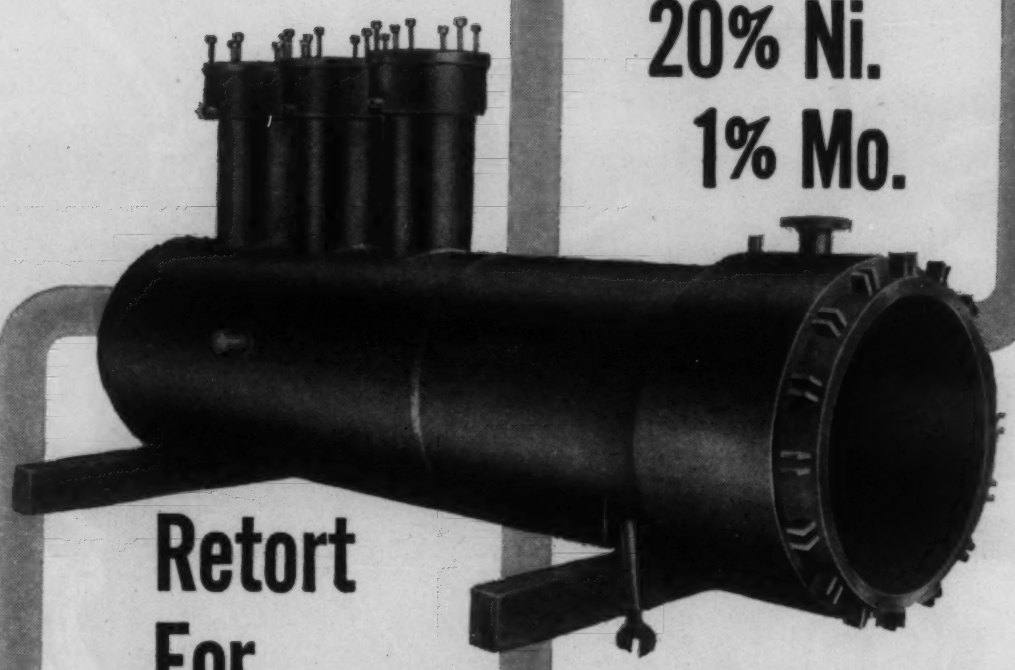
DURASPUN

30% Cr.
20% Ni.
1% Mo.



Retort For Defense Project

Perhaps the most interesting feature of this Duraspun High Alloy Casting is that four different sizes of centrifugal castings are involved. These vary from 34" to 3½" in diameter. Sections, outlets, collar bands, lugs etc., were all welded together in our shop to form the retort as you see it in the picture. Assembled weight runs around 7,464 pounds.

High alloy castings is our business—not merely the adjunct of an extensive steel founding business. We have the experience — 30 years in the static casting division and 20 years on centrifugal castings. We pioneered both kinds of castings in this country. And we have excellent testing and checking facilities, including a 400,000 volt X-ray machine and gamma-ray units.

If you would like this combination of wide experience, modern shop practice, up-to-date equipment and full testing facilities working on your next high alloy casting, bring it to us.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. · Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office: THE DURALOY COMPANY, 805 New Center Building

Atlanta: I. M. TULL Metal & Supply Co. · Chicago: F. O. NELSON 332 S. Michigan Avenue · San Francisco: JOHN D. FENSTERMACHER 1241 Taylor Street

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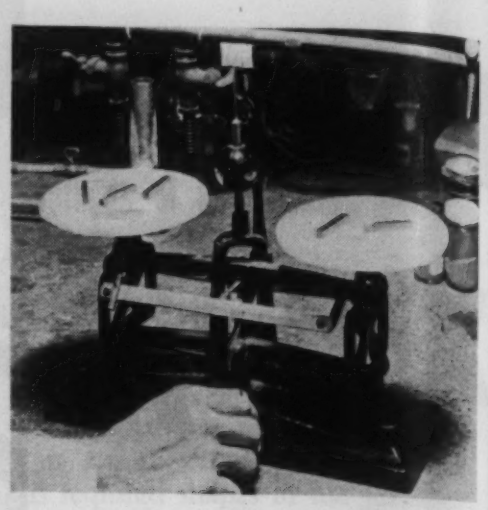
Chromium Carbide . . . .

Continued from page 170



Four pieces of the new lightweight cemented carbide, Grade 608 Chrome Carbide, weigh the same as two pieces of tungsten carbide.

They should be grit-blasted and rinsed clean with a solvent. Although ground or smooth surfaces do not bond well, as sintered or sand blasted surfaces on carbides produce satisfactory bonds.

Bond shear strengths of from 5000 to 8000 psi at room temperature have been obtained with ethoxyline cements of several manufacturers using various curing methods. At 200 F, bond strengths decrease to one-half the above values. Prolonged immersion in water weakens the bond about 15%.

Carbide parts that have been attached by ethoxyline resin cements can be removed by heating the joint to 600 F, at which temperature the cements decompose and the parts can be easily pried loose. The charred cement can be removed by sanding or scraping.

Thermosetting resin cementing of chromium carbide parts for wear resistant applications is often a useful technique, especially where brazing is impossible or inconvenient to apply.

Typical Applications

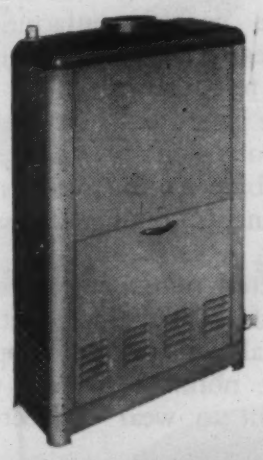
The excellent corrosion and erosion resistance of Grade 608 Chrome Carbide, combined with good abrasion resistance, point to successful applications in broad fields in industry.

In the chemical field, its resistance to acids and sodium hydroxide indicates that nozzle and control valve components are ideal applications. In the pharmaceutical and food processing fields, Grade 608 will also find applications in valves and nozzles because of its resistance to citric and lactic acids. Scraper blades for cen-

(Continued on page 174)

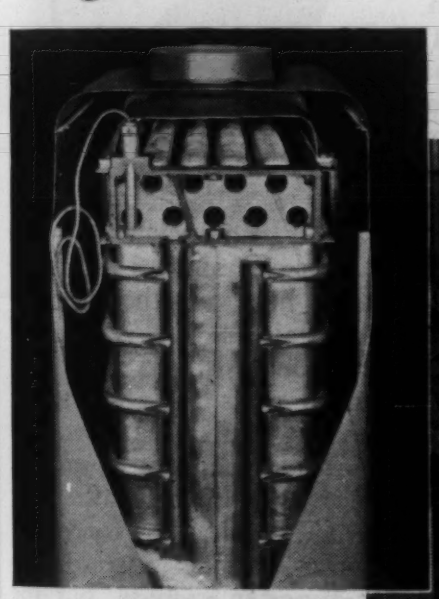
WHEN YOU *MUST* HAVE Strong Leak-tight Ductile JOINTS

...braze with EASY-FLO

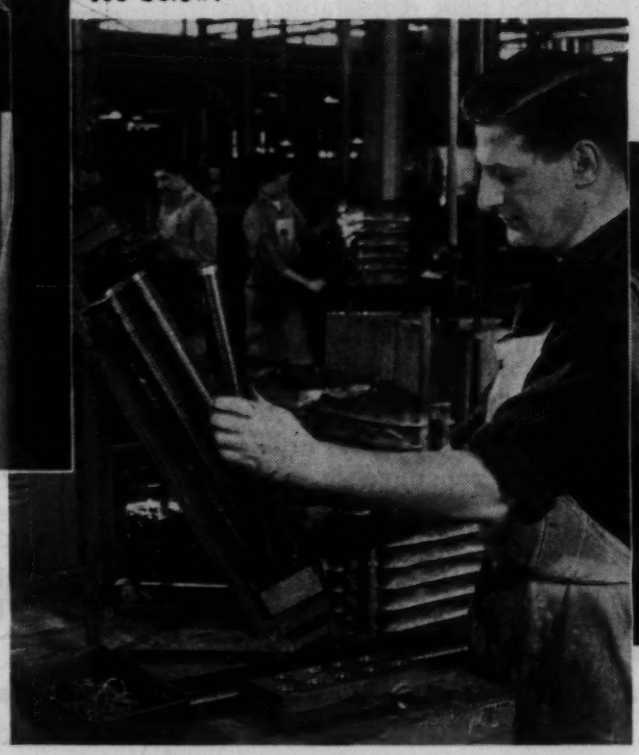


• This low-temperature silver brazing alloy just naturally and consistently makes joints that have all three of these properties—and does it fast and at surprisingly low-cost. That's why you'll find so many manufacturers in the heating, air conditioning and refrigerating industries brazing with EASY-FLO. The well-known RUUD water heater is a typical example. Here's the *inside* story.

Copper tubes are first brazed to large copper tube manifolds (above) — and then jigged and brazed to copper jacket. 3/32" EASY-FLO 35 wire does these jobs using torch heating — time, jigging included, 10 minutes. The same basic construction is used in RUUD house heating boilers.



Copper finned tubes and bronze headers are assembled in jigs with 1/16" EASY-FLO 45 wire rings at each joint — then brazed by dipping in hot salt bath as you see below.



AT YOUR CALL

Expert aid in applying EASY-FLO brazing to your metal joining. No obligation. Ask for a Field Engineer.

GET THE WHOLE *EASY-FLO* BRAZING STORY

BULLETIN 20 tells you in detail what EASY-FLO is, what it does, and how to put it to work—plus valuable information on joint design and fast brazing production methods. Write for a copy today.

85th Anniversary — HANDY & HARMAN — FOUNDED 1867 — QUALITY · SERVICE

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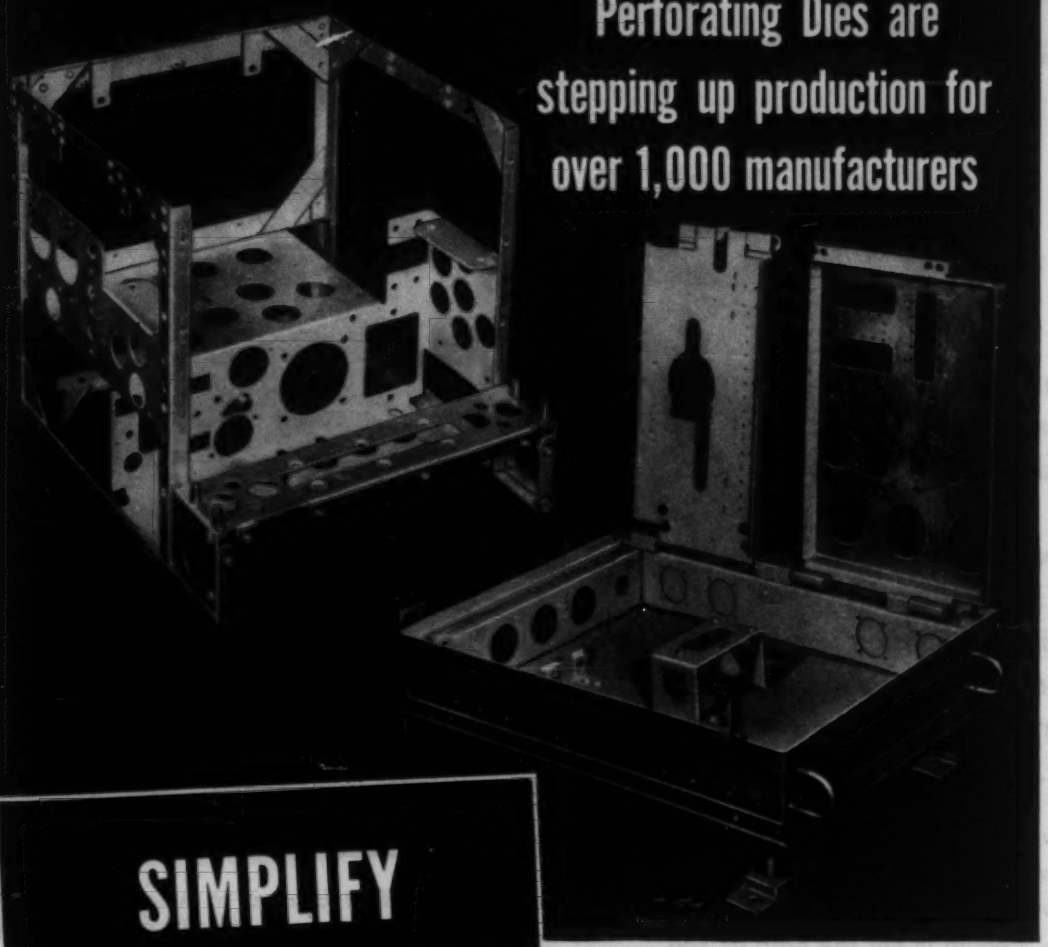
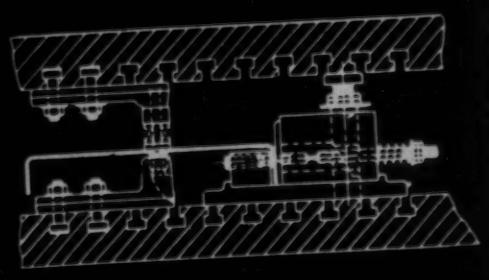
Whistler Adjustable and Magnetic Perforating Dies are stepping up production for over 1,000 manufacturers



SIMPLIFY COMPLICATED PIERCING OPERATIONS



Use this HU-50 90° Perforating Unit on the same job with other Whistler Dies ... often saves extra press operations.

USE WHISTLER Adjustable and Magnetic Dies for perforating, notching and slotting sheet metals ... fast, accurate and cost cutting. Complicated patterns can be set up quickly. Hole arrangements can be changed in the press ... without waiting and at no extra cost. New HU-50 units, that pierce at 90° angle, can be used in conjunction with standard perforating equipment. Fewer press operations are necessary.

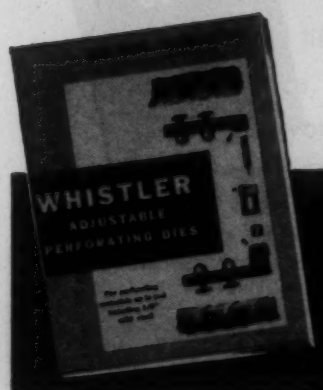
Re-use the same dies in different arrangements on many jobs. Punches and dies are interchangeable.

Whistler Adjustable Dies can be used in practically every type press. Standard sizes and shapes of punches and dies available up to 3 inches. Special sizes and shapes to order.

S. B. WHISTLER & SONS, Inc.

756 Military Road

Buffalo 23, New York



For prices and application data on this modern way to speed production and cut unit costs, write for these illustrated Whistler catalogs.

Chromium Carbide . . . .

Continued from page 172

trifuges and seal rings for homogenizing equipment are other excellent chromium carbide applications. The petroleum industry in which valve components must resist abrasive fluids and corrosive liquids containing salts can also make good use of Grade 608 parts.

Because chromium carbide has about the same thermal expansion rate as steel, it is finding wide application in the gage manufacturing field where wear resistance of gaging surfaces and temperature effects of expansion are important considerations. The corrosion resistance of chromium carbide gaging surfaces is also a factor in prolonging gage surface life.

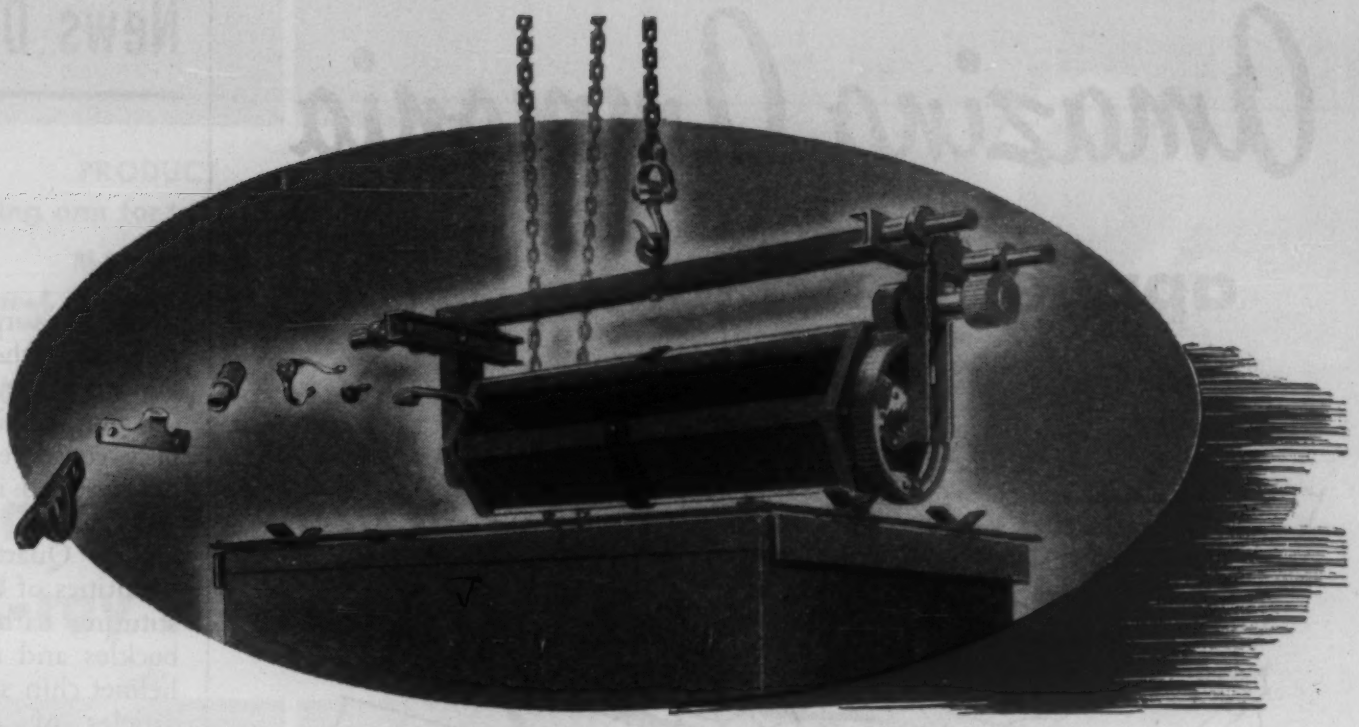
The completely nonmagnetic properties of Grade 608 mean that it is possible to make instrument components that are nonmagnetic and yet highly resistant to wear and corrosion.

There are many other divergent applications for Grade 608, such as: shear blades for molten glass; core pins for baking ceramic parts; fishing rod guides that resist salt water atmospheres; textile machinery guides; mold components for die casting processes; punches for movie film; and a host of other applications where stainless steel is not sufficiently abrasion resistant.

Mechanical parts for all types of machinery that must resist wear, corrosion, high temperatures or erosion are, of course, naturals for the new carbide. Some applications for Grade 608 Chrome Carbide may overlap those for tungsten carbide, but the properties of this new carbide exceed tungsten carbide in so many specific factors that this will undoubtedly prove to be the exception rather than the rule.

Manuals Still Available!

Reprints of the majority of the "Materials & Methods Manuals" are still available. See page 255 for a complete list of these Manuals.



Plating on Aluminum made EASY with Alumon

Hundreds of manufacturers throughout the United States are now using electroplated aluminum. The Alumon process is simple. The work is merely cleaned, dipped in acid, dipped in Alumon and is then ready for electroplating with copper, nickel, and other metals. The process is suitable for plating most wrought and cast alloys. . . The cost of using Alumon is low, being less than half a cent per square foot of surface area treated. The process can be fitted easily into regular plating cycles. Bulk or barrel plating readily done. Upon request we'll gladly send you the Alumon Process Bulletin.

Write for literature on Alumon and check list of literature on sixty Enthone products and processes for better metal finishing.

*TRADE-MARK REG. U. S. PAT. OFF. MANUFACTURED UNDER U. S. PATENT 2,142,564.

METAL FINISHING PROCESSES

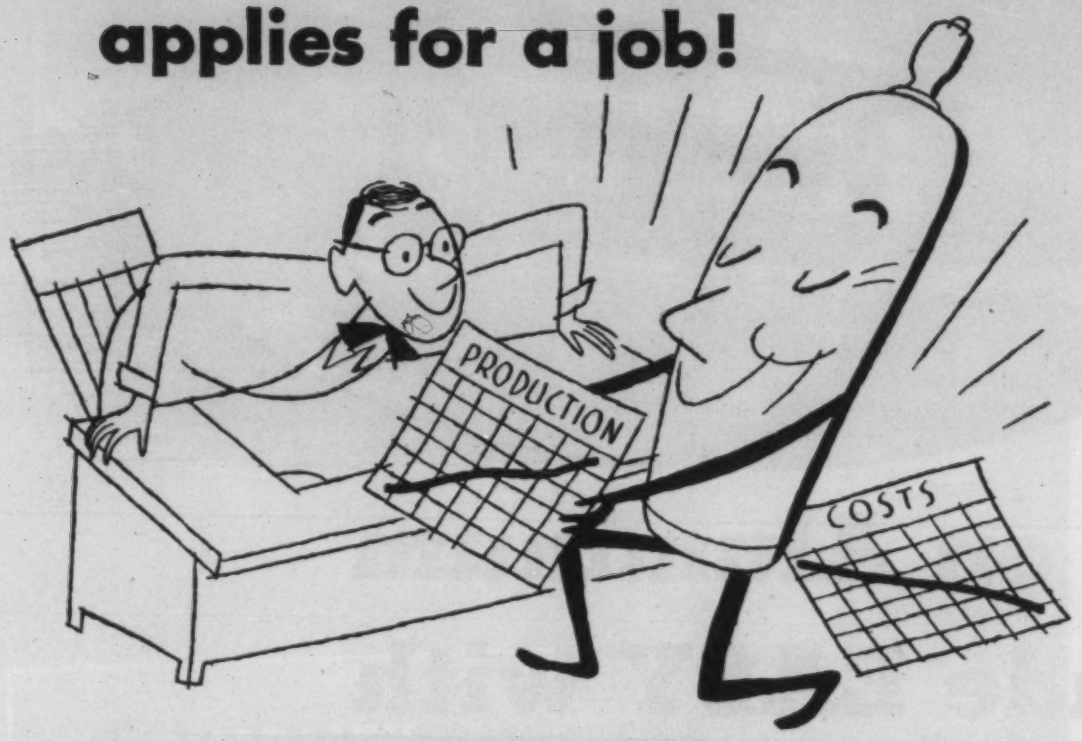
ENTHONE
INCORPORATED

ELECTROPLATING CHEMICALS

442 ELM STREET
NEW HAVEN, CONNECTICUT

Amazing Ammonia

applies for a job!



If ammonia, the versatile chemical, applied for a job, the interview would probably go like this:

EMPLOYER: How old are you?

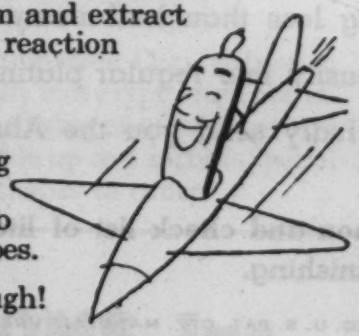
AMMONIA: Many centuries. I helped the ancient Egyptians bleach cloth 3,000 years ago.

EMPLOYER: Amazing! But what do you do today?

AMMONIA: I grow farm crops, make ice, purify water, produce explosives.

EMPLOYER: I know you are a fertilizer, a refrigerant, and . . .

AMMONIA: Yes, and I serve as a protective atmosphere to surface-harden and anneal vital parts of planes and automobiles. I neutralize acid in petroleum and extract metals from ores. I'm a solvent and reaction medium in organic synthesis, a nutrient for yeast and a processing agent in the manufacture of alkalis, rayon, dyes, butadiene, and catalysts for cracking petroleum. I'm used in making vitamins, sulfa-drugs and radio and television parts and tubes.



EMPLOYER: Whoa—that's enough! What can you do for us?

AMMONIA: Just let one of our technical men talk it over with your chemists. He can usually find an answer that will speed up some process and save you dollars.

Barrett* Brand Anhydrous Ammonia in Cylinders

FORMERLY SOLD BY THE BARRETT DIVISION
NOW SOLD BY

Nitrogen Division

ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

*Reg. U. S. Pat. Off.

News Digest

continued from page 13

stock of surplus wheel assemblies for which there was no present requirement could be adapted for use on gun carriages. This action not only conserved 454,000 lb of steel, but resulted in monetary savings of $114,560.

The Quartermaster Corps saved quantities of copper and zinc by substituting carbon steel for brass in buckles and clips on such items as helmet chin straps, gloves, and other articles of uniform apparel. The Transportation Corps saved 39,000 lb of steel by using wood ends, flooring, sides and sheathing in gondola-type railway cars.

As a result of modifications of equipment, and changes in specifications adopted in the third quarter of fiscal 1952 (Jan., Feb., Mar.), the Army estimates it will be able to save the following amounts of strategic and critical materials in the final quarter:

Copper	1,010,137 lb
Zinc	425,856 lb
Nickel	145,023 lb
Aluminum	226,445 lb
Manganese	12,091 lb
Molybdenum	5,288 lb
Steel	493,890 lb
Seamless Steel Tubing	110,013 lb
Vinyl Film	163,350 lb

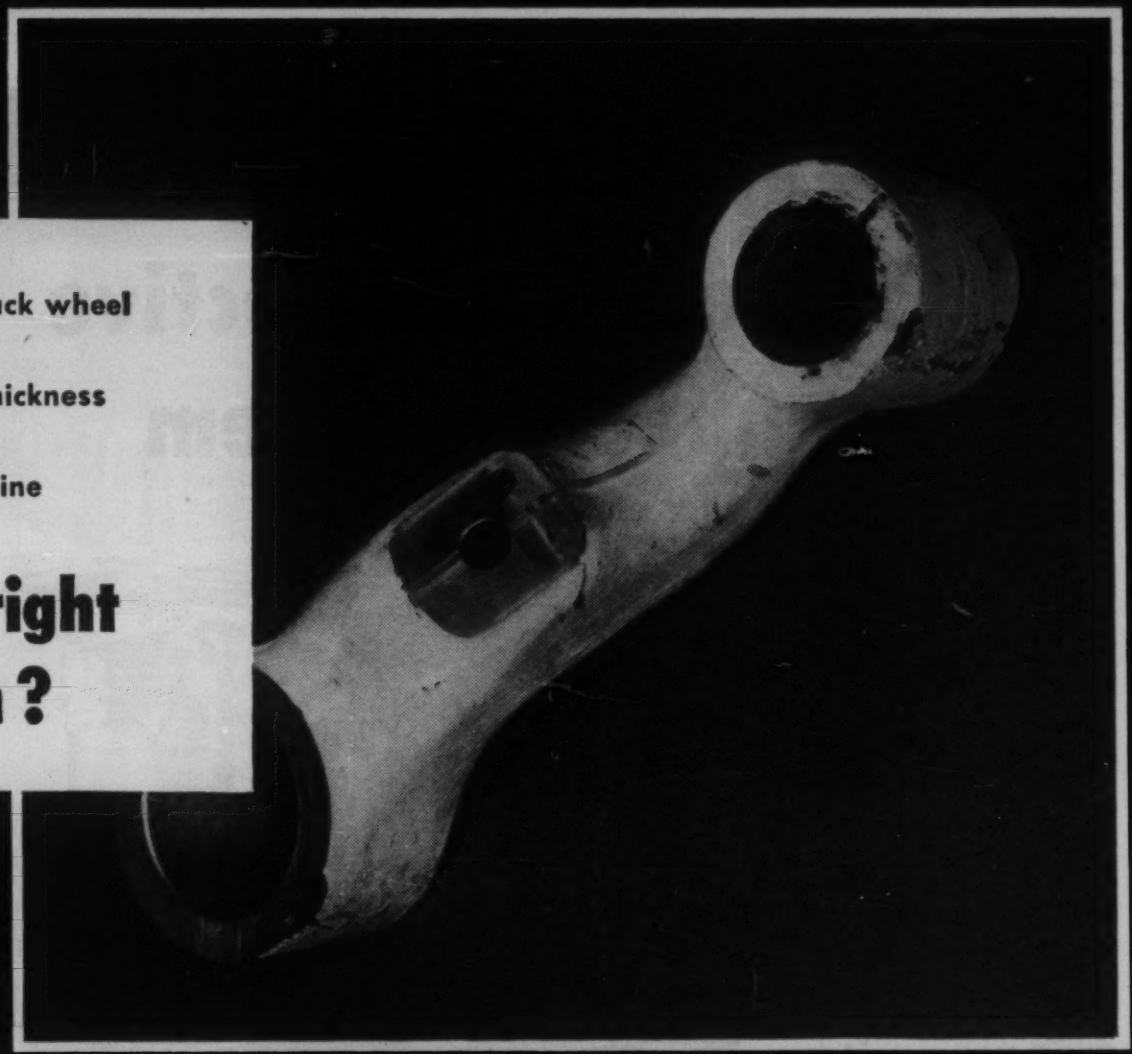
These savings are in addition to those announced previously under the same program.

High Quality Mica Shortage Grows

Lack of readily available supplies of high-quality mica continues to be one of the difficult problems in defense mobilization, according to the National Production Authority.

Radar, jet engines, guided missiles and directional instruments demand increasing quantities of high-quality mica, which is found principally in the mines of India and Brazil. The available supply from these chief sources is decreasing and uncertain at present.

Vacuum tubes for guided missiles are one example of today's produc-



PRODUCT
Supporting arm for tank track wheel

MATERIAL
Cast steel 3" minimum thickness

EQUIPMENT
1000 kv X-ray machine

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

This arm for a tank's rear track wheel has a tough job to do. It must not fail. For the best assurance of its dependability, each one is radiographed.

To make the radiographs, the radiographer made use of Kodak Industrial X-ray Film, Type A,1000 kv, with .010-inch lead screens front and back.

Type A has the speed, high contrast and fine graininess needed to take full advantage of high kilovoltage machines in radiographing thick or dense materials. It also allows the examination of light alloys with reasonably short exposures at low voltages.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check castings and welds efficiently and thus extend the use of both processes.

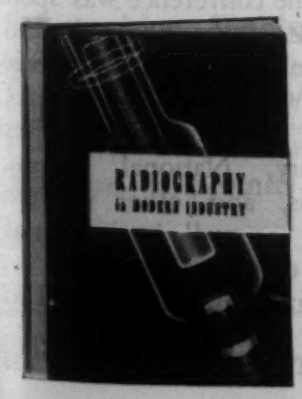
Type A—has high contrast with time-saving speed for study of light alloys at low voltage and of heavy parts at 1,000 kv and higher. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma-ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

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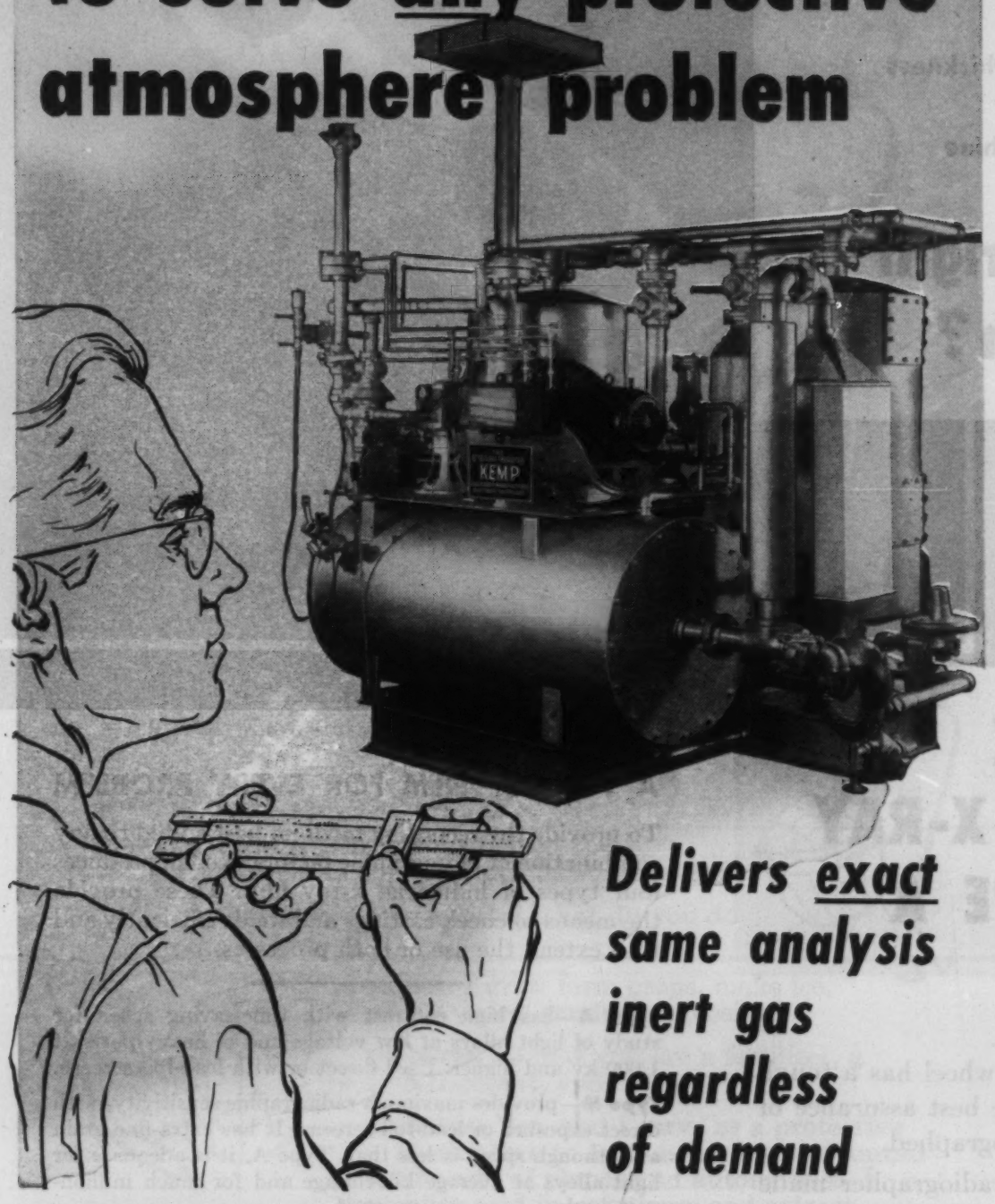
You can count on KEMP to solve any protective atmosphere problem



Delivers exact same analysis inert gas regardless of demand

DAY AFTER DAY Kemp users throughout the metals field report: Kemp Atmosphere Gas Generators *maintain* exact analysis of chemically clean atmosphere gas *regardless* of demand . . . *eliminate* the possibility of mixture fluctuations at some critical phase of processing. These same users report big gas and maintenance savings with Kemp. Also Kemp Generators are fast-starting, easy-to-operate . . . offer real savings in both *time* and *money* by reducing the costly warm-up period necessary for starting. You can't go wrong when you specify Kemp Atmosphere Gas Generators.

Set it . . . forget it!

The Kemp Industrial Carburetor, standard equipment and the very heart of every Kemp installation, assures you complete combustion . . . without tinkering . . . without waste. Uses ordinary gas right from mains. Every Kemp Design includes complete up-to-the-minute fire checks and safety devices. Why not find out how Kemp can help you with your problems, today?

KEMP OF BALTIMORE

GAS GENERATORS

Write for Bulletin I-10 for technical information

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News Digest

tion, which require increasing quantities of high-quality mica. While these tubes are much smaller than the old fashioned type used in radio, and use less mica in their individual construction, their quantities have increased many times since World War II days.

New processes for manufacturing sheet mica by various methods of reconstituting mica scrap show gratifying progress. But NPA officials emphasize that substitutes can be used only in place of low-quality mica and are of little value in the defense program.

A long-range purchasing program by the Government, to encourage the discovery, development and production of mica has been launched by the General Services Administration.

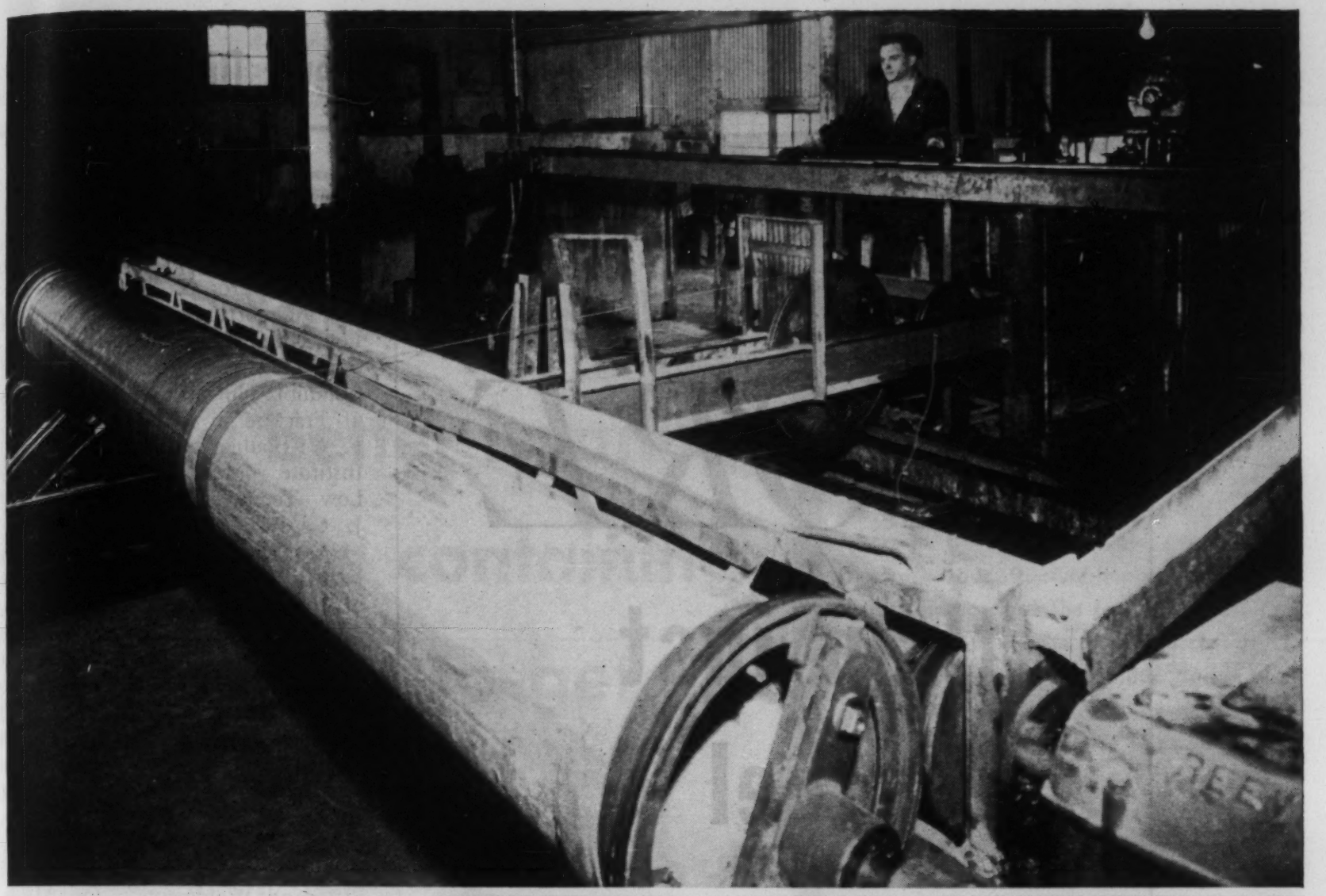
Conference on Materials and Design for Low Temperature Service

An important advance in the solution of cold weather problems was made at a two-day conference on materials and design for low temperature service held recently at the Engineer Research and Development Laboratories, Fort Belvoir, Va.

A comprehensive correlation was made of the data currently available on low temperature properties of metals and on designs suitable for Arctic operation. By pointing up the gaps in present knowledge, this correlation will guide further research. It will also supplement engineering handbooks which contain little or no scientific or engineering data on this subject.

Experts from the Armed Services, Government and industry participated. The conference was sponsored by the Engineer Research and Development Laboratories' Scientific Council. Cooperating with the Council were Ordnance, Naval Research Laboratory, National Bureau of Standards, and other Government agencies, as well as industrial and research organizations.

The first day was devoted to con-



After a concrete lining is spun centrifugally or poured inside a steel cylinder, Bethlehem high-tensile steel wire is wound around the cylinder.

Coated with rich cement mortar, finished pipes in 16-ft lengths depart for duty. Pre-stressed concrete pipes are made with diameters varying from 16 in. to 48 in.

Photographs courtesy of Lock Joint Pipe Company

BETHLEHEM WIRE GOES UNDERGROUND in Pre-stressed Concrete Pipe

When pre-stressed concrete pipe goes to work steel wire hugs every inch of it, helping to counteract tremendous water pressures.

Wound under high tension by a special machine, Bethlehem wire compresses — or pre-stresses — the steel-and-concrete core. The wire adds tremendously to the strength of the pipe. It permits a lighter weight of finished pipe than could be obtained by using other systems of concrete reinforcement.

Wire for pre-stressed concrete pipe is a Bethlehem specialty. We are continually developing many kinds of steel wire to meet special requirements and new uses. Bethlehem engineers will be glad to contribute their experience to any problems you may have in the selection and processing of steel wire.

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BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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Personalized service is the big "plus" you get when you come to us for your warehouse steel requirements.

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UNITED STATES STEEL

News Digest

sideration of ferrous base metals, including ship plate. Among the speakers were: G. Manning of Battelle Memorial Institute, "History of Low Temperature Property Evaluation Tests"; Dr. M. Gensamer of Columbia University, "Fundamentals of Fracture in Metallic Materials"; F. W. Boulger of Battelle Memorial Institute, "Metallurgical Aspects of Low Temperature Behavior"; Dr. J. C. Fisher of General Electric, "Low Temperature Properties of Ferritic Alloys"; Dr. O. T. Marzke of the Naval Research Laboratory, "Relation of Transition Temperature of Chemical Composition"; S. Tour of Sam Tour & Co., "Low Temperature Applications of Steel at High Hardness Levels"; N. Kahn of New York Naval Shipyard, "Significance of the Tear Test in Evaluation of Ship Plate"; W. E. Pellini of the Naval Research Laboratory, "Performance Evaluation of Structural Plate and Weldments"; Dr. M. L. Williams of the National Bureau of Standards, "Brittle Fracture in Ship Plate"; E. M. MacCutcheon of the Bureau of Ships, "Low Temperature Structural Failures versus Design"; D. E. Driscoll of Watertown Arsenal, "Reproducibility of the Charpy V-Notch Test"; and G. S. Mikhalapov of Metallurgical Research and Development Co., "Direct Explosion Tests on Plate."

On the second day, low temperature properties and applications of nonferrous metals were discussed. Speakers were: D. C. Rollins of Union Carbide and Carbon Corp., "Design Criteria for Low Temperature Applications"; F. M. Howell of Aluminum Co. of America, E. Shuette of Dow Chemical Co., and Dr. W. L. Finlay of Rem-Cru, "Low Temperature Properties and Applications of Light Metals and Alloys"; J. Juppenlatz of Lebanon Steel Foundry, and Dr. P. Payson of Crucible Steel Co., "Low Temperature Properties and Applications of Austenitic Alloys"; G. W. Geil of the National Bureau of Standards, "Low Temperature Properties and Applications of Heavy Nonferrous Metals and Alloys"; H. Schwartzbort of the Armour Research Foundation, "Limitations of Present Knowledge of Low Temperature Properties."

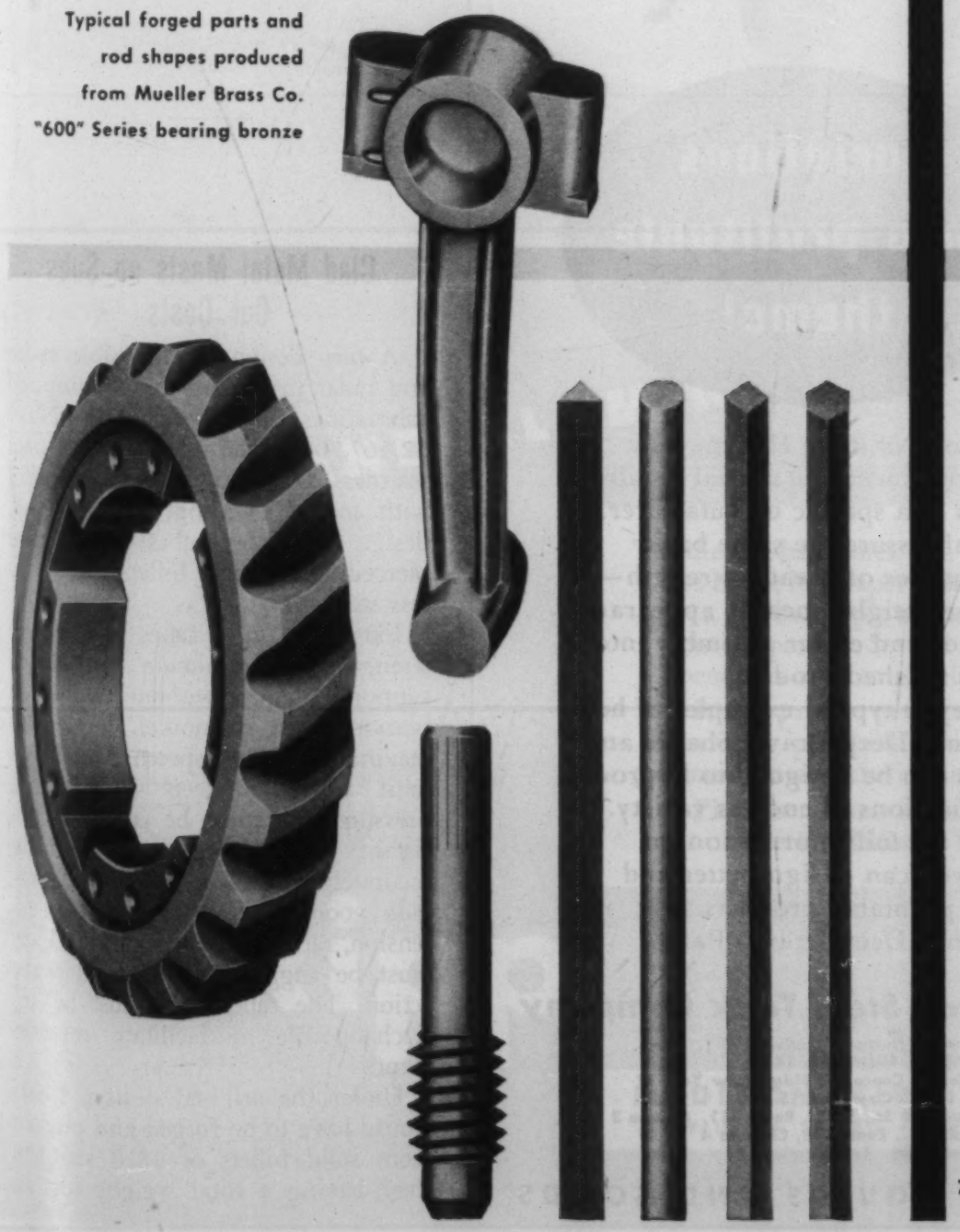
Discussions were held on the following topics: "Low Temperature

MUELLER BRASS CO.

"600" SERIES

a better bearing bronze containing no-hard-to-get tin

Typical forged parts and rod shapes produced from Mueller Brass Co. "600" Series bearing bronze



If you use gears, connecting rods or other parts requiring bearing properties, it will pay you to investigate "600" Series, a high strength bronze that *contains no tin*. "600" Series outperforms phosphor bronzes and other bearing metals . . . it will also save time, money, and material. "600" Series bearing metals can be forged into relatively complicated shapes and produce a forging of close-grained homogeneous structure impossible to get in a sand casting. The forged shape is closer to finished size than a casting, often requires less machining, and eliminates the need of a bushing. "600" Series is available in standard and special extruded shapes in 12′ mill lengths. These alloys have a low coefficient of friction, a tensile strength 2½ times greater than cast phosphor bronzes and high resistance to corrosion. There is a "600" Series alloy with the properties to fit your bearing metal need...write today for further facts.

MUELLER BRASS CO.

PORT HURON 20, MICHIGAN

73

variations on a profitable theme!

Each one of these Hackney air receivers meets the special requirements of a specific manufacturer. Yet, all assure the same basic advantages of greater strength—lighter weight—neater appearance—faster and easier assembly into user's finished product.

They're typical examples of how Hackney Deep Drawn Shapes and Shells can be designed to fit product specifications in endless variety. Write for full information on how you can design better and more profitable products with Hackney Deep Drawn Parts.

Write for a complimentary copy of our anniversary booklet, "Design for Progress."

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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

News Digest

Metallic Materials of the Future," led by N. E. Promisel, Bureau of Aeronautics; "Low Temperature Welded Design of the Future," Dr. Finn Jonassen, NRC, Ships Structure Committee; "Low Temperature Studies Which Should Be Sponsored by the Government or Private Industry," E. L. Hollady, Office, Chief of Ordance; and "Current Sources of Information on Low Temperature Properties," J. Johnson, Wright Air Development Center.

Moderators were F. B. Foley, of The International Nickel Co., Inc., New York; Dr. Finn Jonassen, NRC, Ships Structure Committee, Washington, D. C., and Dr. J. G. Thompson and T. G. Digges, both of the National Bureau of Standards.

The results of the conference will be published by the Office of Technical Information, Dept. of Commerce.

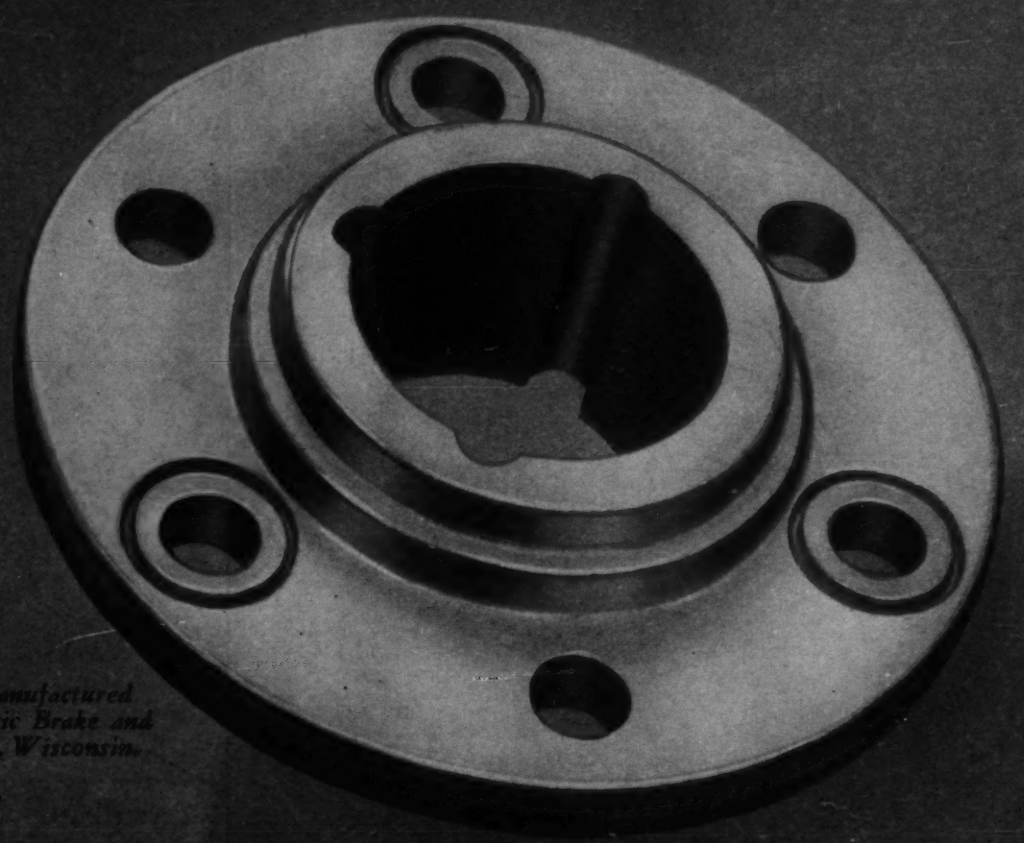
Clad Metal Masts on Subs Cut Costs

A new design of extensible radio and radar masts for snorkel-equipped submarines is saving the Navy $2,567,700. The new mast uses seamless drawn low alloy steel tubes with monel cladding. The original design called for tubes forged and pierced from solid billets of stainless steel.

Extensible mast tubes must have strength with minimum weight, to support antennas without undue vibration when at snorkel depth and maximum snorkel speed. The tubes must withstand deep submergence pressure, and must be corrosion resistant. They must have smooth, accurately machined exteriors to provide good bearing surfaces for extension, retraction and rotation. They must be rugged to withstand wave action. The tubes also must be interchangeable to facilitate replacement.

Under the original design, masts would have to be forged and pierced from solid billets of 18:8 stainless steel having a total weight for all

DESIGNING to advantage



Part illustrated manufactured for Warner Electric Brake and Clutch Co., Beloit, Wisconsin.

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The die cast half holes, full holes, spring recesses and center hole taper make this plain looking part a good example of the advantages of the die casting process. Several difficult machining operations are completely eliminated.

It may pay you to review your own designs for die casting possibilities that will bring you continuing manufacturing and marketing advantages.

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THE GEAR THAT COULDN'T BE MADE!

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That's why they came to Powdered Metal Products Corporation of America . . . the gears, made from a special bearing bronze in production quantities, cost less than fifty cents each!

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News Digest

the masts to be made of 11,320 tons. The total finished weight of the masts would be only about 400 short tons. This meant that 10,920 tons of metal would have to be machined away and scrapped.

The total program for the new tubes requires about 340 tons of steel tubing, very little of which is machined away, and 125 tons of monel cladding, of which 50 tons are machined away.

Porcelain Enamel Institute Plans Forum

The 1952 shop Practice Forum of the Porcelain Enamel Institute will be held on Sept. 10, 11 and 12 at the University of Illinois.

The first day's session will be devoted to summaries of the latest developments in the industry. Fluorescent enamels, low temperature enamels, one-coat whites directly on steel and stable colors in titania opacified enamels will be discussed, together with other subjects. Enameling of aluminum will be covered on the second day. In the afternoon of the second day, the military needs for high temperature ceramic coatings and their possible post-war applications will be discussed. Control practices will be the subject on the 12th. The meeting will conclude with a panel discussion.

Metals Saved by Electronics Industry

In an address at the Electronics Parts Show in Chicago, Donald S. Parris, of the National Production Authority, gave a summary of efforts to save scarce metals in the electronics field.

Mr. Parris noted that the receiving

from 1/8" *to* 40" **OD**

WHEN YOU NEED STAINLESS STEEL TUBING

TRENTWELD *will meet your needs best*

Name an industrial application that calls for stainless steel tubing — and the tubing to name is TRENTWELD. Available in diameters from 1/8" to 40" OD TRENTWELD presents a broad range of grades, gauges and finishes.

Study the product and the plant where it is produced and you find the reason for the steady increase in TRENTWELD usage. For TRENTWELD is made in a *tube* mill by *tube* experts who roll and weld stainless and high alloy tubing without added rod metal. This Trent method results in metallurgically correct tubing with a uniform section and uniform corrosion resistance.

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AMERICAN CHEMICAL PAINT COMPANY

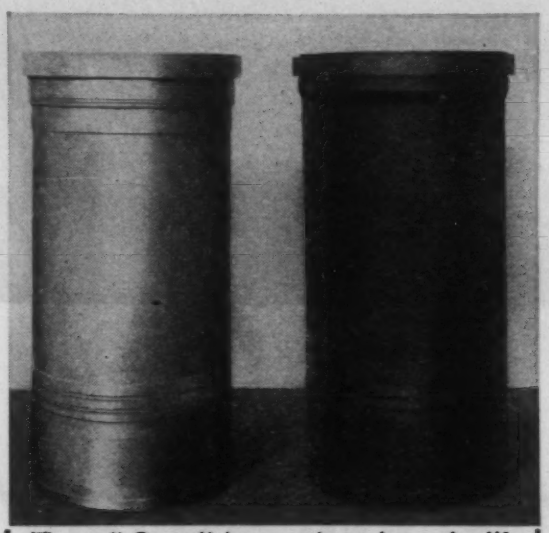
AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: PROTECTING FRICTION SURFACES WITH THERMOIL GRANODINE®

INTRODUCTION

Fabricators and product designers, particularly in the automotive field, are aware that even highly polished surfaces under friction weld, gall and score. One of the most inexpensive and practical methods of preventing this is to coat the metal to prevent metal-to-metal contact. With cast iron or steel, the "Thermoil-Granodine" manganese-iron phosphate coating provides a wear-resistant layer of unusual effectiveness.



Thermoil-Granodizing greatly prolongs the life of parts subject to friction. It protects the surface of products like the diesel engine liners shown above and the many moving parts of automobiles and other machines. "Thermoil-Granodine" with its remarkable lubricating properties is particularly valuable in these and similar applications because of its ability to retain oil and maintain lubrication under high pressures and high velocities. This ACP wear-proofing chemical not only permits rapid break-in without scoring, scuffing and welding but also reduces subsequent wear on friction parts.

"THERMOIL-GRANODINE" PROTECTS RUBBING PARTS

Thermoil-Granodizing removes "fuzz" from ferrous metal friction surfaces and produces a coating of non-metallic, water-insoluble manganese-iron phosphate crystals which soak up and hold oil as bare untreated metal cannot do. The oiled crystalline "Thermoil-Granodine" coating on piston rings, pistons, cylinders, cylinder liners, cranks, cam-shafts, gears, tappets, valves, spiders and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, welding, galling and tearing of the metal. The work to be protectively treated is merely Thermoil-Granodized and oiled, usually with a soluble oil.

"THERMOIL-GRANODINE" MEETS THESE SPECIFICATIONS

SPECIFICATION NUMBER	SPECIFICATION TITLE
MIL-C-16232 Type I	Coatings — phosphate; oiled, slushed, or waxed (for ferrous metal surfaces) and phosphate treating compounds.
AN-F-20 (See also U.S.A. 3-213)	Finishes, for electronic equipment.
U.S.A. 57-0-2C Type II, Class A	Finishes, protective, for iron and steel parts.
U.S.A. 51-70-1 Finish 22.02, Class A	Painting and finishing of fire control instruments; general specification for
M-364	Navy aeronautical process specification for compound phosphate rust-proofing process.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "THERMOIL-GRANODINE" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

News Digest

tube industry reduced the use of nickel by approximately 50% by using nickel-plated steel and aluminum-clad iron for elements instead of pure nickel. This was done with no reduction in quality. Speaker manufacturers reduced the weight of Alnico V magnets by 45%, saving this percentage of nickel and cobalt. By using electrostatic deflection-type cathode ray tubes instead of electromagnetic tubes, the television receiver industry has saved approximately 40% of the nickel and cobalt used for this application.

Selenium rectifiers for television receivers resulted in an average reduction in silicon steel of 7½ lb and in copper wire of 1¼ lb per receiver. Large savings of copper were made by reducing wire diameters and by the use of copper-clad steel wire. Savings of copper were also made in marine antenna design by using copper electroplated steel core wire. In this application, 85% of the copper which otherwise would have been used was saved.

A reduction of 50% in steel usage in television receivers was accomplished by reducing the steel gage in the chassis and by improved designs.

Electromagnetic Pump Moves Molten Metals

A new a.c. electromagnetic pump with no moving parts, for pumping liquid metals and other low resistance conducting fluids at temperatures up to 1000 F, has been announced by the Special Products Section of the General Electric Co.

According to engineers of the company's General Engineering Laboratory who developed it, the pump can be used to move any conducting fluid that has a specific resistance equal to or less than stainless steel (approximately 90 microhm-cm). Liquid metals, such as sodium, sodium-potassium alloys and lithium, fit this classification.

The new pump operates on the principle that a current-carrying conductor in a magnetic field is acted on

Machine tool idea pool

In designing machine tools, as in planning countless other products, OSTUCO Steel Tubing provides an endless pool of practical ideas because of its *unlimited adaptability*. Collets, chucks, spacers, spindles, bearings, shafts, ferrules, and handles are but a few of the applications.

By varying the radius of a bend, the length of a taper, the dimension of an upset, etc., an old design can be improved or a new one created. By combining such operations, a part can be made to serve several functions, thus simplifying design. Parts may even be fabricated or forged beyond recognition as a tube section.

Whether you design machine tools or products of a distinctly different nature, you will want to investigate the many quality-improving, cost-reducing features of OSTUCO Tubing. We cannot always promise early delivery estimates on new civilian orders, because of military demands, but it will pay you to consult our experienced engineers about OSTUCO Tubing when redesigning your products to meet future competition.

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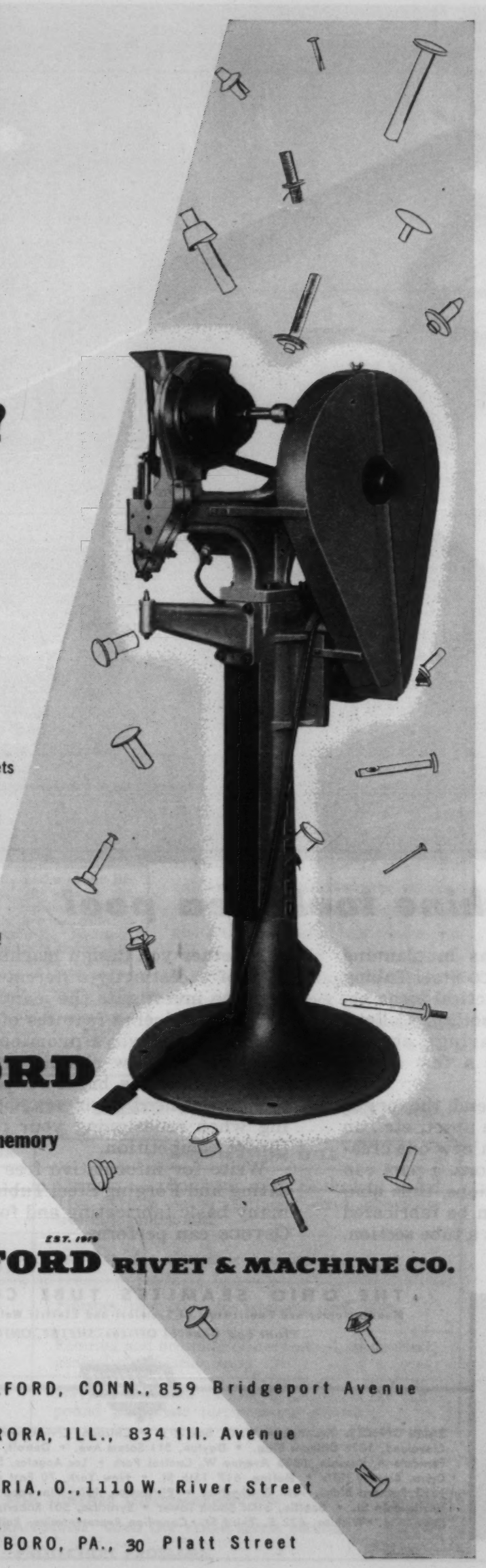

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News Digest

by a force. In this case, the fluid serves as the conductor, so that when current and flux are properly applied, pumping occurs.

One of the three basic elements of the pump, a transformer unit, sets up a high current through the liquid metal and, simultaneously, a magnetic field perpendicular to that current. A cell unit, which consists of a flattened stainless-steel pipe, carries the liquid metal through the magnetic field. The third basic part, a capacitor unit, povides power factor correction.

Symposium on Extremely Large Forgings and Extrusions

With a view to emphasizing to aircraft design engineers the need for the expanded utilization of larger and more complex forged and extruded structural components in forward aircraft designs, a symposium will be held as part of the meeting of the American Society of Mechanical Engineers in December in New York City. The symposium will present all the principal elements involved in the problems of the creation and the utilization of such new components.

Four national technical societies have consented to cooperate in the organization and presentation of the symposium. These societies are the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, the Institute of Aeronautical Sciences, and the Society of Automotive Engineers.

Authorities in their respective fields will present five important papers during the symposium. J. Carlton Ward, Jr., general chairman of the symposium, will open the proceedings, presenting highlights regarding the development of the joint meeting. George W. Papen, of Lockheed Aircraft Corp., will present the first paper, "Requirements for Large (Light Metal) Forgings and Extrusions in the Aicraft Industry." The second paper, "The Design and Construction of Large Forging and Extrusion Presses for Light Metals," will be given by Dr. Morris Stone, United Engineering and Foundry Co., Pittsburgh. The third paper, to

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HEAT AND CORROSION RESISTANT

AN ASSEMBLY THAT *"Gives a Lift"* TO AN IMPORTANT HEAT TREATING JOB

Four sets of these Stacking Furnace Baskets were custom-fabricated by Rolock to fit pit-type furnaces built by Hevi Duty Electric Company. Photo at left shows bottom grid, mesh disc, lift straps and fastening keys. Photo at right shows complete assembly ready for furnace.

They are used by a nationally known manufacturer for hardening at 1850° F. Material of basket is type 330 stainless steel. Size, each basket 28" I.D. x 12¾" high. To facilitate handling in and out of the furnace the baskets are securely fastened together with alloy lift straps and keys. Note fabricated bottom grid and mesh disc. All welding is of the highest quality.

Rolock equipment is engineered to suit the specific job...for maximum strength...for as high ratio of load to weight as safety permits ...for handling convenience...and for low hour-cost through extended service life. Our engineering department likes to solve problems. Tell us about yours!

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Easier Operation, Lower Cost

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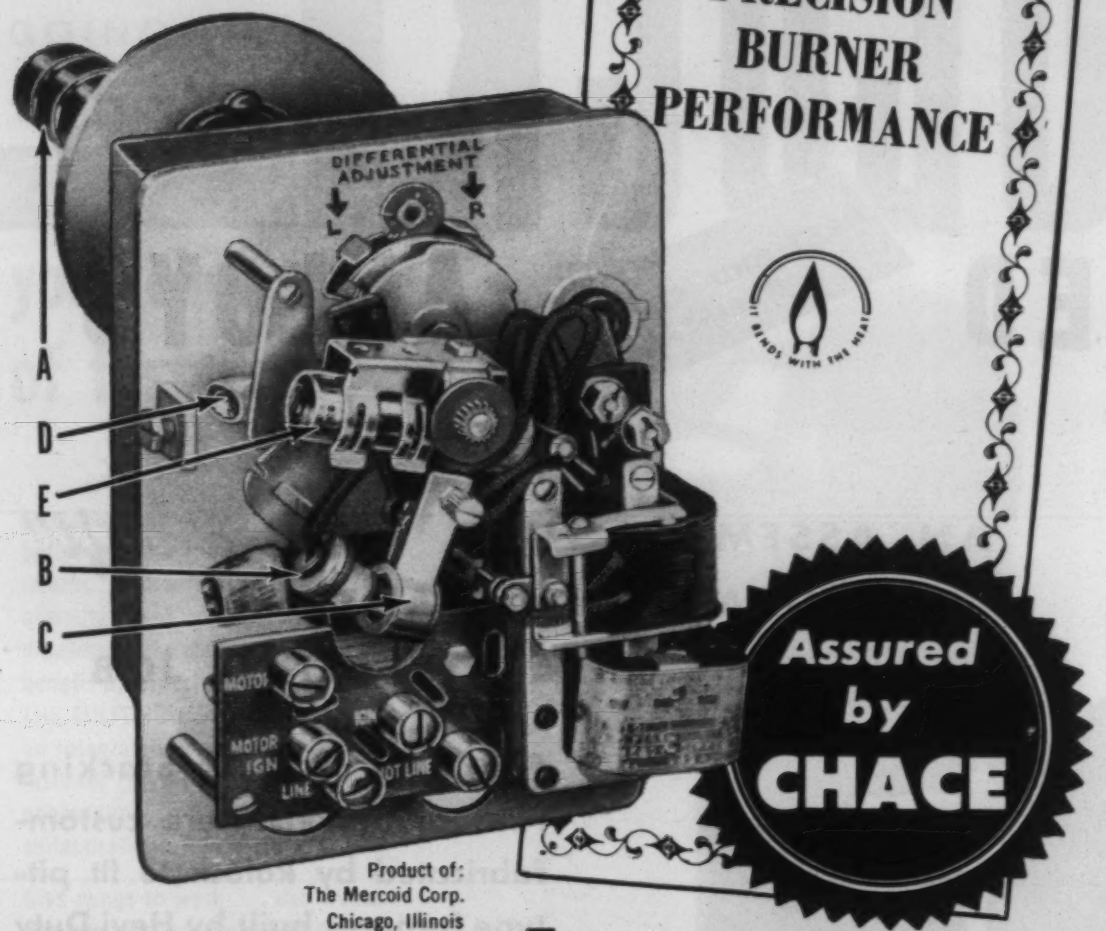

Product of:
The Mercoid Corp.
Chicago, Illinois

This precision built Mercoid JMI Pyratherm provides positive protection against flame or ignition failure of automatic oil burners. The Pyratherm, actuated by Chace Thermostatic Bimetal, insures having the ignition circuit closed before every starting operation of the burner. The safety mechanism operates on a closed circuit principle; opening of any circuit prevents burner operation until it has been returned to the normal starting position.

During normal operation, the rise in stack temperature will actuate bimetal coil "A" in the stack and cause heater coil "B" to move away from bimetal loop "C" and open ignition switch "D" Should ignition fail to occur when the burner is started, heater coil "B" remains within bimetal loop "C" as the stack temperature does not rise. The current flowing through coil "B" heats up the bimetal loop "C" and stops the burner after the predetermined time has elapsed for which the safety has been set. In the event of flame failure, the stack temperature lowers causing the heater coil "B" to move into bimetal loop "C" and after predetermined time, safety switch "E" releases and stops the burner.

If the actuating element of your new control device is thermostatic bimetal, Chace can furnish it completely fabricated, ready for assembly. Our 29 types of bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. Before proceeding with your next design, consult our application engineers, recognized authorities on temperature responsive devices, or write today for our new 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

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News Digest

be presented by Thomas L. Fritzlen of the Reynolds Metals Co., is titled "Metallurgy and Production of Suitable Light Metal Ingots for Large Forgings and Extrusions." George Motherwell, Wyman Gordon Co., Worcester, Mass., will deliver a paper, "The Large Forging Press Operation and Its Production Problems." "The Large Extrusion Press and Its Production Problems" is the subject of the fifth paper, by T. F. McCormick, Aluminum Co. of America.

Basic Materials and Alternates

The Defense Production Authority has issued another list of basic materials and alternates. This list was compiled to reflect the relative availability of materials and to help save critical materials by indicating more available alternates. A partial resume of the list, with the most critical materials carrying a star, follows:

Metals

Group I-A
(In short supply)

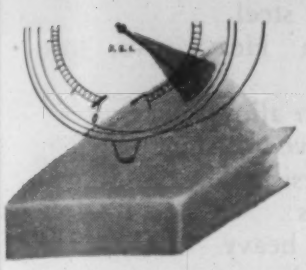
a—Nonferrous:
- Aluminum
- *Beryllium
- Copper
- Magnesium
- *Selenium
- *Titanium
- Tin

b—Precious:
- Iridium
- Platinum

c—Ferrous alloying elements:
- *Cobalt
- *Columbium
- *Molybdenum
- *Nickel
- *Tantalum
- Tungsten

d—Ferrous:
- Bars, cold drawn:
  - Alloy
  - *Carbon steel
- Bars and semifinished, hot-rolled:
  - Alloy
  - *Carbon Steel
- Castings:
  - Carbon steel
  - *Carbon steel, heavy over 3000 lb

Beat Pressure...



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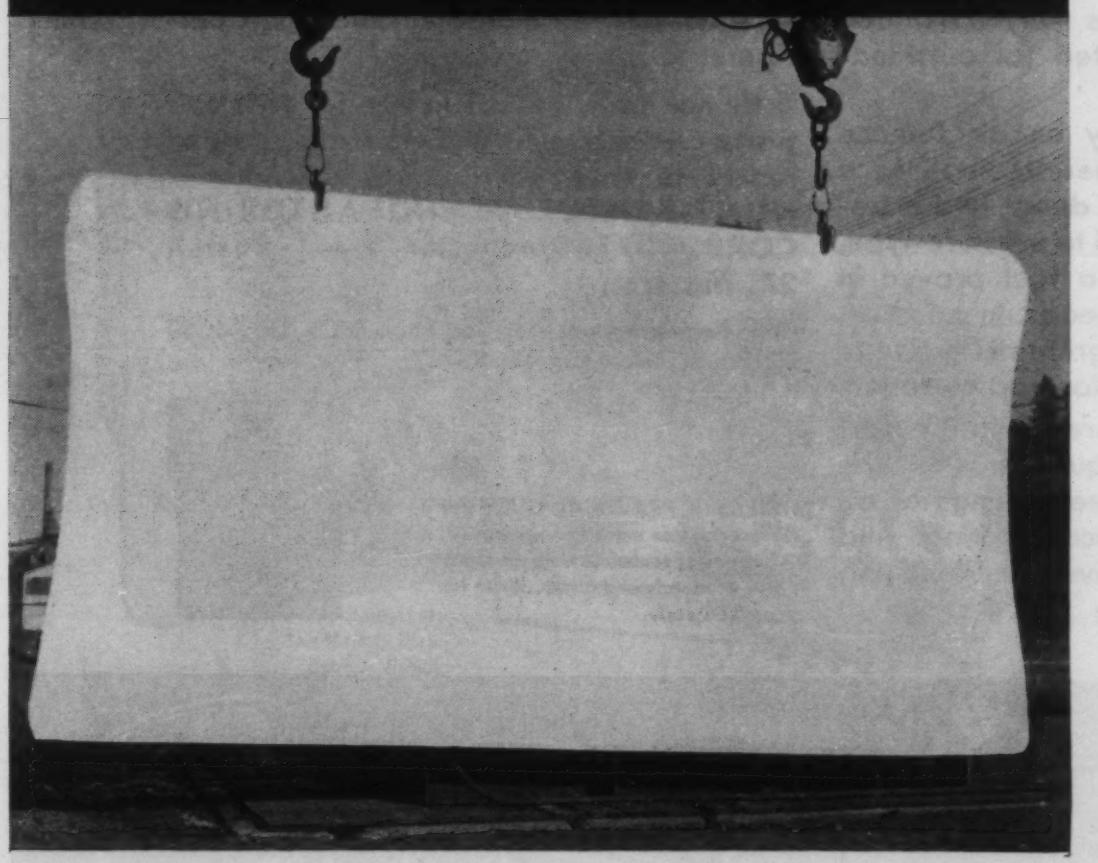

Type 304 Size 5/8" x 162" x 327".

Whether the stainless plate is large, such as that illustrated, or small—whether it is a full plate or pattern cut blank—G. O. Carlson, Inc. is the quick, sure source upon which the chemical, petroleum, and metal working industries depend.

Our large stock of plates in a wide variety of analyses, sizes, and thicknesses, is augmented by specialized cutting facilities and techniques. This saves you much time and effort, and reflects considerably on the over-all costs of material.

All Carlson stainless steel plate is produced to chemical industry standards, and is available in all analyses.

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Steel, high alloy:
Corrosive resistant
Heat resistant
Die blocks
Forgings, heavy
Iron powder
Pig iron, low phosphorus
Pipe:
Seamless, all sizes
Welded:
4 in. and over
3 in. and under, galvanized
Places
Rails
Shapes, structural
Sheet, galvanized
*Stainless steel: Nickel bearing
Strand wire, galvanized
*Tubing, seamless:
Alloy mechanical
Alloy pressure
Carbon, mechanical
Carbon, pressure

Group II-A
(In approximate balance)

a—Nonferrous:
Calcium
Germanium

b—Precious:
Osmium

c—Ferrous alloying elements:
Chromium
Manganese
Vanadium

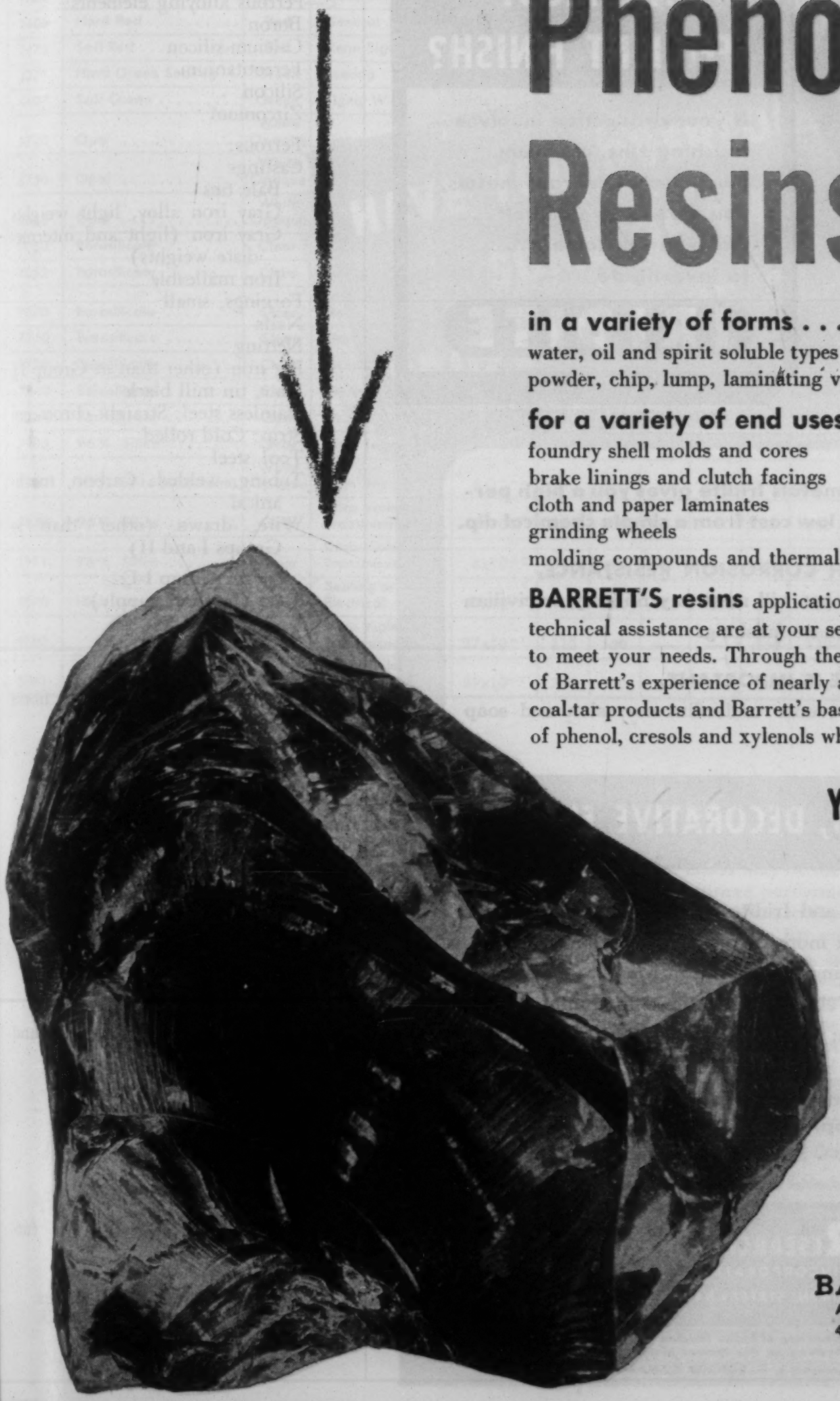
d—Ferrous:
Forgings, medium
Pipe welded: 3 in. and under (except galvanized)
Plate, tin
Rods: Hot rolled
Sheet: Cold rolled
Hot rolled
Strip: Hot rolled
Wire, drawn: welding, quality

Group III-A
(In fair to good supply)

a—Nonferrous:
Antimony
Bismuth
Cadmium
Lead
Mercury
Tellurium
Zinc

b—Precious:
Gold
Palladium
Rhodium
Ruthenium

Barrett Phenolic Resins



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water, oil and spirit soluble types . . .
powder, chip, lump, laminating varnishes and bonding solutions

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foundry shell molds and cores
brake linings and clutch facings
cloth and paper laminates
grinding wheels
molding compounds and thermal insulation

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News Digest

Silver

c—Ferrous alloying elements:
- Boron
- Calcium-silicon
- Ferrotitanium
- Silicon
- Zirconium

d—Ferrous:
- Castings
  - Bale ties
  - Gray iron alloy, light weights
  - Gray iron (light and intermediate weights)
  - Iron malleable
- Forgings, small
- Nails
- Netting
- Pig iron (other than in Group I)
- Plate, tin mill black
- Stainless steel: Straight chromium
- Strip: Cold rolled
- Tool steel
- Tubing, welded: Carbon, mechanical
- Wire, drawn (other than in Groups I and II)

Group I-D
(In short supply)

- Asbestos:
  - Amosite
  - Chrysotile:
    - Crude and spinning fibers
    - Shingle fibers
  - Crocidolite
- *Diamonds, industrial: Bort
- Graphite, natural:
  - Crucible flake
  - Ceylon: High carbon amorphour lump
- Mica:
  - Muscovite block and film, good stained and better
  - Bookform splittings
- *Rare earths
- Rubber:
  - Natural, dry:
    - Pale crepe, grades 1X-1 and 2
    - Sole crepe

Group II-D
(In approximate balance)

- Abrasives, synthetic:
  - Aluminum oxide
  - Silicon carbide
- Carbon electrodes: Electric furnace
- Corundum
- Diamonds, industrial: Stones
- Fluorspar:
  - Ceramic
  - Metallurgical

Glass Code	Type	Color	Principal Use	Thermal Expansion Coeff.—/°C	UPPER WORKING TEMPERATURES (Mechanical Considerations Only) Annealed Normal Service °C	Annealed Extreme Limit °C	Tempered Normal Service °C	Tempered Extreme Limit °C	Thermal Shock Res. Plates 6"x6" Annealed ⅛" Thk. °C	Annealed ¼" Thk. °C	Annealed ½" Thk. °C	Thermal Stress Resistance °C	Viscosity D Strain Point °C	Annealing Point °C	Soft
0010	Potash Soda Lead	Clear	Lamp Tubing	$91x10^{-7}$	110	380	—	—	65	50	35	19	397	428	6
0041	Potash Soda Lead	Clear	Thermometers	$84x10^{-7}$	110	400	—	—	70	60	40	19	426	460	
0080	Soda Lime	Clear	Lamp Bulbs	$92x10^{-7}$	110	460	220	250	65	50	35	17	478	510	
0120	Potash Soda Lead	Clear	Lamp Tubing	$89x10^{-7}$	110	380	—	—	65	50	35	17	400	433	6
1770	Soda Lime	Clear	General	$82x10^{-7}$	110	450	220	250	70	60	40	19	470	503	7
2405	Hard Red	Red	General	$43x10^{-7}$	200	480	—	—	135	115		36	506	537	8
2475	Soft Red	Red	Neon Signs	$91x10^{-7}$	110	440	—	—				17	466	501	6
3321	Hard Green Sealing ..	Green	Sealing	$40x10^{-7}$	200	470						39	497	535	7
4407	Soft Green	Green	Signal Ware	$90x10^{-7}$								17	485	518	6
6720	Opal	White Opaque	Gene									19	499	531	
6750	Opal	White Opaque										8	445	475	
6810	Opal	White Opaque											496	529	
7050	Borosilicate	Clear											461	496	7
7052	Borosilicate	Clear	K										438	475	7
7070	Borosilicate	Clear	Lo Ele										455	490	
7340	Borosilicate	Clear	Gau									20	538	575	7
7720	Borosilicate	Clear	Elect							130	90	45	484	518	7
7740	Borosilicate	Clear	Gene					290	180	150	100	48	515	555	8
7760	Borosilicate	Clear	Electr			450	250	250	160	130	90	51	475	515	7
7900	96% Silica	Clear	High Te	10^{-7}	800	1090	—	—	1250	1000	750	200	820	910	15
7900	96% Silica (Multiform)	White Opaque	High Temp.	$8x10^{-7}$	800	1090	—	—	1250	1000	750	200	820	910	1
7910	96% Silica	Clear	Ultra Violet Transmission	$8x10^{-7}$	800	1090	—	—	1250	1000	750	200	820	910	15
7911	96% Silica	Clear	Ultra Violet Transmission	$8x10^{-7}$	800	1090	—	—	1250	1000	750	200	820	910	15
8870	High Lead	Clear	Sealing or Electrical	$91x10^{-7}$	110	380	180	180	65	50	35	22	398	429	5
9700	.....	Clear	Ultra Violet Transmission	$37x10^{-7}$	220	500	—	—	150	120	80	42	517	558	8
9741	.....	Clear	Ultra Violet Transmission	$39x10^{-7}$	200	390	—	—	150	120	80	40	407	442	7

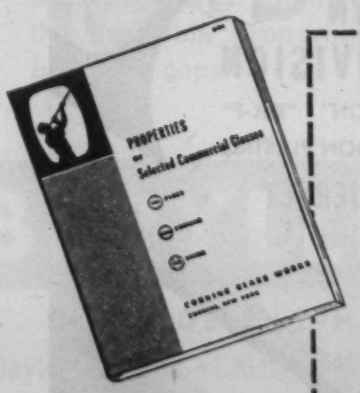
HAVE YOU OVERLOOKED SOME OF THE PROPERTIES OF GLASS?

Glass is such a commonplace material, it's easy to overlook the many properties it can be made to possess—properties which may well prove the answer to your material problem. The above table suggests the wide variations in glasses available at Corning for various applications. You'll find Corning has hundreds of glasses with other important characteristics you may need—unusual corrosion resistance, high physical and thermal shock resistance, optical clarity, and controlled light transmission, to name a few.

Take a fresh look at your present and projected equipment. Glass may be the material you're looking for to improve performance and lower costs. Then bring your ideas to Corning and let our engineers choose a glass for you. We have the glass and technical experience, backed up by research and pilot plant facilities, to develop your idea, and a broad variety of production facilities to produce it. For a quick look at some properties of glasses by Corning, send the coupon below for Bulletin B-83, "Properties of Selected Commercial Glasses."

1851
100 YEARS OF MAKING GLASS
BETTER AND MORE USEFUL
1951

Corning means research in Glass



Corning Glass Works
Dept. MM-8, Corning, N.Y.

Please send me Bulletin B-83, "Properties of Selected Commercial Glasses."

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Pure Teflon* and Chemelec Mixtures, which are "alloys" of Teflon, offer product engineers a whole new family of materials.

Undoubtedly you are familiar with the properties of pure Teflon — its chemical inertness, its unapproached dielectric qualities, its serviceability at temperatures from —110° F. to 500° F., its extreme anti-hesiveness, its zero water absorption.

Now, Chemelec Mixtures further broaden the scope of this wonder plastic. If you want Teflon that can be soldered or cemented, you may have it. If you want Teflon, "alloyed" with metal, glass, ceramics, carbon, mica, quartz, alnico, asbestos, silicate, calcium, or boron, etc., to meet a particular material requirement, you may have it, too.

Bring us your problem and our engineering department will work with yours to determine the material best suited to your needs.

***du Pont's trademark for its tetrafluoroethylene resin**

News Digest

Graphite, artificial: Electrodes, anodes and special shapes
Mica:
Phlogopite, splittings
Muscovite block and film (Lower than good stained)
Muscovite splittings, loose
Quartz crystals (MBS Grades I and II)
Refractories:
Chromite
Silicon Carbide
Sillimanite
Rubber:
Butyl (GRI)
Natural, dry (other than in Group I)
Synthetic (GRS), cold

Group III-D
(In fair to good supply)

Asbestos, Chrysotile: Shorts and waste fibers
Emery
Fuller's earth
Pumice
Refractories:
Dolomite
Fire clay
High alumina
Magnesite
Silica
Resins:
Copal
Damar
Elemi
Kauri
Sandarac
Rubber:
Natural, latex
Reclaimed
Synthetic (GRS) other than cold
Zircon

Clarification

In "File Fact" No. 229, which appeared in the June issue of MATERIALS & METHODS, a comparison is given of the comparative costs of engineering materials. In the bar chart that was published, some confusion has resulted from the fact that one bar is labelled "cast iron." Properly, the bar should be labelled "pig iron," for the cost of 0.023¢ per lb does not cover the processing of pig iron into cast products.

(More News on page 200)

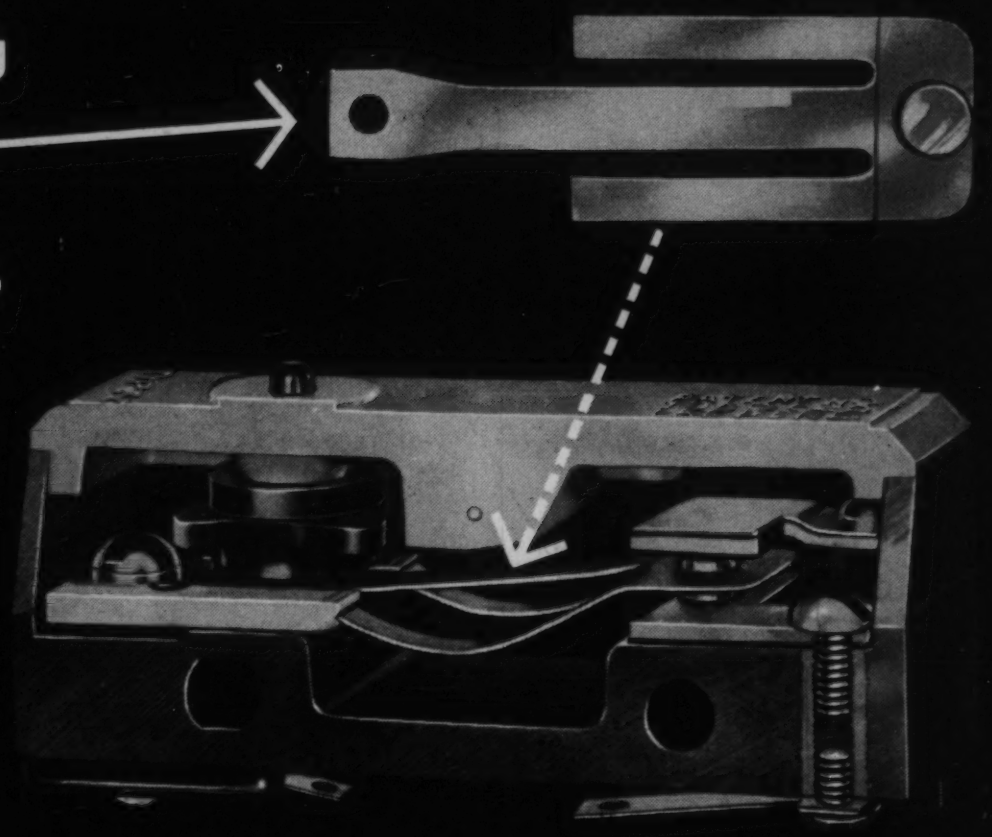
This spring

is the heart

of a

precision

switch



IT'S MADE OF BERYLCO BERYLLIUM COPPER

Designed for dependable operation over millions of cycles, this unit—manufactured by the Micro Switch Division, Minneapolis-Honeywell Regulator Company—is used in the most exacting modern equipment. In critical industrial applications, these switches control machine tools, business machines, instruments and materials handling equipment. In the present defense effort, they play an equally important role in weapons, ships, planes and tanks.

Berylco beryllium copper made possible the design of these switches. Berylco's high endurance strength permits the necessary spring action to be crowded into the required space. Its ability to be hardened after forming permits a one-piece blade. Its greater uniformity permits more constant operating characteristics.

The basic switch, shown here, has an Underwriters' listing of 15 amp., 125, 250 or 460 volts ac. Recent switches, so small that it takes 265 to make a pound, are rated at 5 amp., 125 or 250 volts ac. These are only two of some 5,000 catalog items which can be produced inexpensively and in mass-production quantities because of the desirable properties of Berylco beryllium copper.

It will pay you to find out what Berylco can do for you. Take advantage of the know-how of the world's largest producer. Write or phone any of the offices listed below.

VALUABLE ENGINEERING INFORMATION on Berylco beryllium copper is contained in a series of technical bulletins, published monthly. To receive your copy regularly, write on your business letterhead.

TOMORROW'S PRODUCTS ARE PLANNED TODAY WITH BERYLCO BERYLLIUM COPPER

Sample material available for testing purposes

BERYLCO THE **BERYLLIUM** CORPORATION

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PRC tapes feature natural anti-deterioration and rattle cushioning values. Special impregnations also provide unmatched *protective sealing* characteristics. FOR EXAMPLE:

CHROME LOCK
This product inhibits electrolysis and corrosion. Is also anti-wicking. Seals under pressure. Adhesive back is pressure sensitive. TYPICAL SEALING APPLICATIONS: Instruments; glazing channel window sash; skin laps on bus bodies; weatherseal for trailercoaches.

KLING FELT

Features a new, solvent-activated adhesive (one side only) that sticks to all surfaces. Can be applied to cold metal. WON'T PULL LOOSE!

TYPICAL APPLICATIONS: Weather Strip for windows, doors, etc.; dust and moisture seal for electric control panels; rattle cushioner.

PRE-SEGMENTED

PRC tapes can be supplied in segmented rolls according to order. Each segment is pre-cut to a sufficient depth to permit easy detaching. Ideal for volume application of equal-size pieces.

Write for free test sample and new engineering folder—TF-28

PRC

PRODUCTS RESEARCH CO.
3126 LOS FELIZ BLVD., LOS ANGELES 39, CALIF.
Representatives in All Principal Cities

News Digest

Crucible Expands Testing Facilities

The completion of an enlarged and expanded program of testing and development facilities at Park Works, Crucible Steel Co. of America, has been announced. The additional facilities will permit particular emphasis on simulated sevice testing or the subjecting of the steel at the mill as far as possible to the same conditions it will meet in actual use.

In addition to the latest mechanical testing machines, Park Works has enlarged its simulated service testing for mining and quarrying steels for power and hand saws, as well as steels for many other applications. For developing and testing these special steels for such purposes as power and hand saws, Park Works has also installed additional controlled power saws, all types of tension measuring devices, power input meters, and other devices. For mining and quarrying steel testing, more apparatus, such as steel sharpeners, drifter drills, as well as huge blocks of granite, have been put into use.

All of these facilities are available for cooperative studies on specialty problems.

The Place of Plastics

The June 1952 issue of the *Journal of the Institute of Metals* (London) carried an article by J. J. Standinger on the nature and applications of plastics. Particular attention was given to the fields in which plastics are replacing metals.

It was pointed out that the nature of the bonds in plastics and metals are different. Plastics are based on a covalent bond between elements. The metal bond is considered to be the forces between positively charged metallic ions in an electron atmosphere. The essential differences between the two types of materials are traceable to these bonds.

One thing that stands out in comparing properties is that some aluminum and magnesium alloys are superior in specific tensile properties

A PRACTICAL SOLUTION TO THE

TECHNICAL MANPOWER SHORTAGE PROBLEM

Are you interested in the possibility of getting some of your testing and trouble shooting work done without hiring another man?

Our solution is very direct. No doubt many of your trained engineers and chemists are tied down by routine but essential testing tasks. You can release these men for more demanding, more responsible duties by entrusting our laboratories with your routine testing schedules.

Why is this possible? Because Testing is our Business. Your tests will be handled by men who live, breathe, and think testing. They will receive the care and attention that only a specialized laboratory can give them. That means speed, accuracy, and real economy.

We would like to get together and discuss your manpower problems and possibly point the way to a solution.

Write for booklet describing our services.

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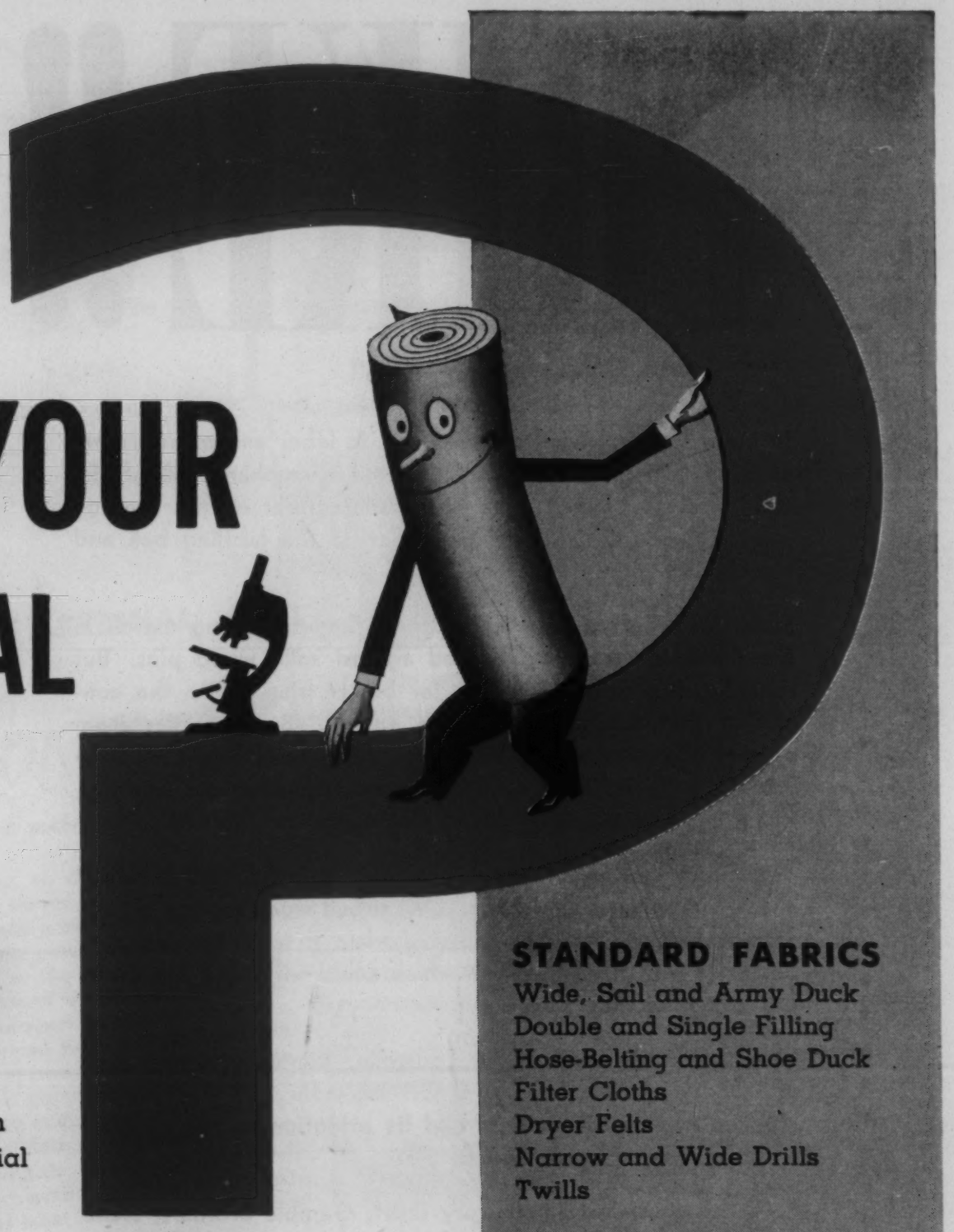
Member of American Council of Commercial Laboratories

WHAT'S YOUR INDUSTRIAL FABRIC PROBLEM



Need some expert advice on the right fabric for your special needs? Want a new fabric developed for a particular purpose — or an existing fabric adapted to a new application? We believe you'll find Mt. Vernon-Woodberry has the skill and experience it takes to work it out. Can we help?

Determining yarn tensile strength with 300-lb. vertical test. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

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Wide, Sail and Army Duck
Double and Single Filling
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AT YOUR SERVICE

Mt. Vernon-Woodberry Mills' staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

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For Calendering, Laminating and Other Industrial Applications

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STRIKE!!

In industry, it's a frightful word . . . to labor and management alike. On the bowling alley, it's the triumphant yell of the scoring team. But . . . to the manufacturer of the bowling pin, it means the shattering impact of the hurtling ball and ricocheting pins.

Since long before Henrik Hudson's famed bowling match in the Catskills, men have bowled against solid wood pins. But recently, the constant search for better pins led to the conclusion that lamination was the answer. Building pins from several pieces of wood, indestructibly bonded, could virtually eliminate the faults of solid-block pins: checking and splitting, chunking, and breaking off at the neck.

The theory was sound but in practice "indestructibly bonded" seemed an impossible hurdle. One proud woodworking organization after another was humbled when it tried but failed to come up with the lamination which could withstand the grueling test of bowling alley use.

Finally Gamble Brothers, in Louisville, Kentucky, whose staff of wood engineers has an almost legendary 50-year reputation for accomplishment, turned its attention to the problem of the much-battered bowling pin.

To make an already long story short, Gamble Brothers, drawing, among other things, on their extensive experience with the laminating of heavy ship timbers and marine parts, came up with the answer the industry had been waiting for. It went into production . . . and still produces superior laminated bowling pins which are guaranteed not to come apart in a glue-line!

This is but one aspect of the broad knowledge and practical experience which Gamble Brothers makes available . . . to you, too. Ask freely for Gamble Brothers' help in solving your design or production problems through the use of wood. No obligation. Write today.

Engineered Wood Parts in Southern and Appalachian Hardwoods, Walnut or Mahogany.

GAMBLE BROTHERS, Inc.

Offices and Main Plant: Louisville 9, Kentucky
DIMENSOWOOD Division: Montgomery, Ala.

GAMBLE BROTHERS GB GUARANTEED BOND

INCORPORATED

to plastics and also to many of the heavy metals, with the exception, perhaps, of the highly specialized steels. Even the light metals have their failings, however. Plastics must be conceded some of their domain.

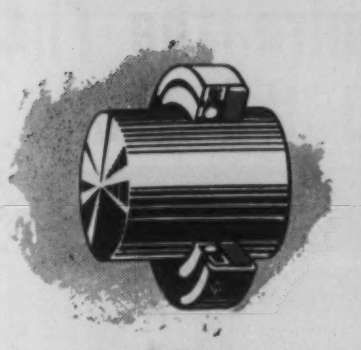
Whereas the impact resistance of plastics is generally better, the elastic modulus is lower than that of metals. Nevertheless, the very satisfactory strength of plastics, particularly of the laminated and reinforced varieties, in which the plastic component represents about 50% by weight, is the reason why these materials are being increasingly used in the construction of fuselage and other structural aircraft components, small naval craft, dinghies and other pleasure boats, housings for portable and transportable mechanical tools and agricultural machinery, bobbins and other textile machinery components, mining helmets, and even bullet-proof body protection. In many of these instances aluminum or its alloys is the metal that can be, and has been, replaced.

One drawback of reinforced plastics, according to the author, is their lack of malleability. This has discouraged applications in automobile bodies. In some places malleability is not desirable, however. Housings for vacuum cleaners and carpet sweepers, textile bobbins, weaver's beam flanges and slip rollers are suitable for plastics.

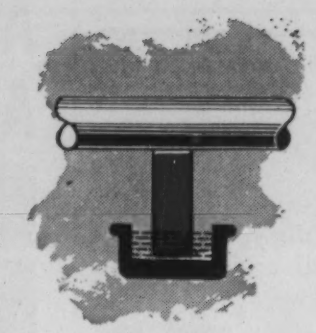
Mr. Standinger also noted that the laminated or reinforced plastics can be used for bearings and bushings, particularly where lubrication with oil presents difficulties. But even with oil as lubricant or with no lubricant at all, plastics provide satisfactory materials for load-bearing, low-friction surfaces. For such purposes the metal powder or fabric-filled phenolic plastics have been developed, and one of the outstanding successes is the use of a fabric-filled phenolic plastic for bearings of all sorts of steel rolling mills.

On the score of the strength/weight ratio, the plastic materials have ample opportunities to replace the heavier metals in a very great variety of applications, although the light metals, aluminum, magnesium and their alloys appear to be the most serious competitors of plastics, since they combine the lightness of plastics with the metallic virtues.

(Continued on page 204)

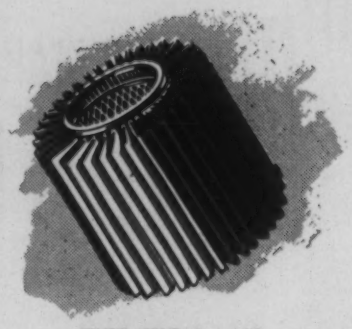


SEALING



WICKING

POLISHING



FILTRATION – AIR

HERE ARE

16

OF THE CARDINAL

uses for FELT

HOW MANY ARE YOU USING?

FELT does many things, so many that probably every day of your life it serves you in some way or another, directly, as in the grease retainers in your car, or indirectly, to make possible your eyeglasses. Illustrated here are 16 of the cardinal mechanical applications, one or more of which should be used to advantage in your product or plant. We invite full investigation. American Felts include hundreds of types for thousands of uses. Each type is held to strict specifications and standards. American Felt maintains an experienced engineering staff, ready to assist you with technical data, or to collaborate with you in selecting and using the correct felt for a given application. Samples are available. Get in touch with American, and discover what modern felt techniques can do for you.

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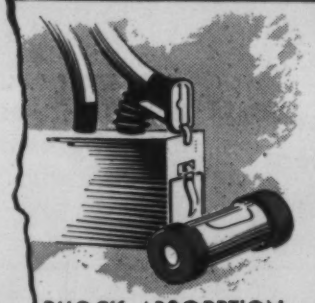
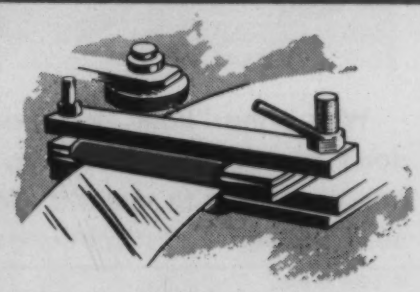
FILTRATION—FLUIDS

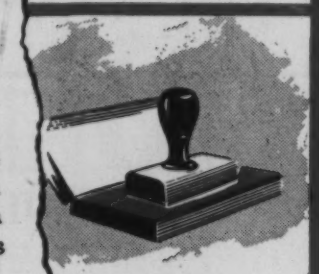
SOUND ABSORPTION & THERMAL INSULATION



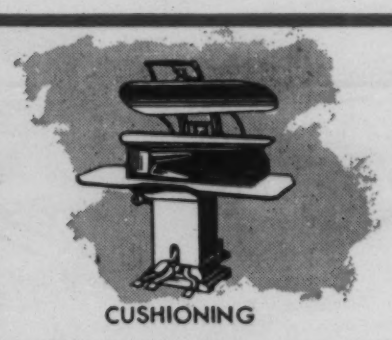
SHOCK ABSORPTION



WIPING



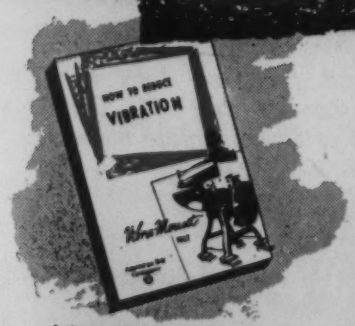
MOISTENING



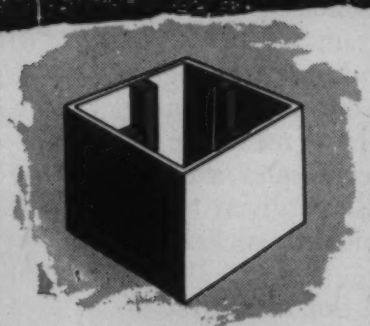
CUSHIONING

PADDING

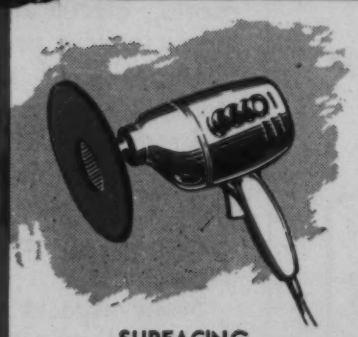
PERCUSSION



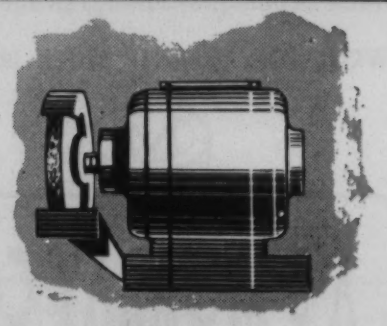
VIBRATION CONTROL
SEND FOR BOOKLET



PACKAGING



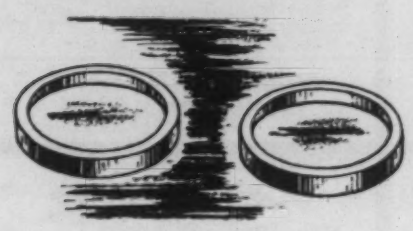
SURFACING



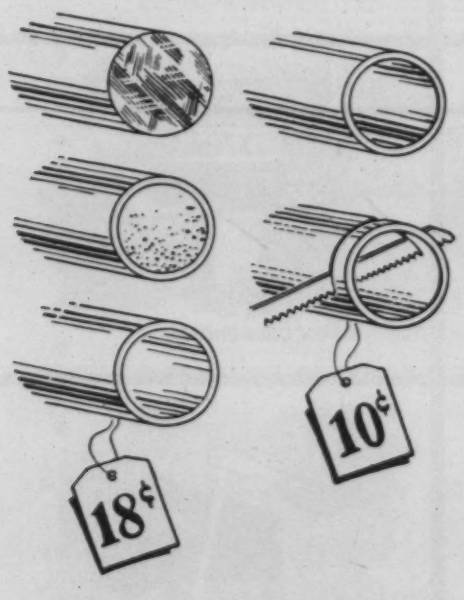
FRICTIONAL

WHY PAY FOR MAKING A HOLE?

If you make an item like these valve seat inserts, give a thought to using Murray tubing. Formerly *machined* from bar stock, they cost 18 cents to produce. Now they are literally *sliced* from Type 304 stainless tubing for a dime apiece.



Where the "hole" is important, don't pay for transportation, storage and labor to make it. Consult our tubing specialists about getting it for free.



Other Murray products include carbon steel tubing and pipe for mechanical and pressure purposes; Welding and screw type pipe and tube fittings. Tube bending, upsetting, swaging.

WRITE FOR CURRENT STOCK BULLETIN

A B MURRAY CO INC
ESTABLISHED 1845
ELIZABETH, N. J. McKEESPORT, PA.

News Digest

However, to the pro-plastic factors of appearance, durability, corrosion resistance, low thermal and electrical conductivity, and low production cost must be added one other important factor, namely that of availability of raw materials.

Now, what does all this replacement of light metals by plastics amount to, in terms of quantities, the author asks. Assuming a yearly production of aluminum of 1.4 million tons and making a very rough, but optimistic, estimate of 8000 to 10,000 tons of plastics used instead of aluminum, that would correspond to about 1%. Whereas a doubling of this would mean a very great progress to the plastics industry, it would still constitute only a minor inroad into the volume of metal, which may be more than compensated by the natural growth of the light-metal industry itself.

Heavy Rhodium Plating

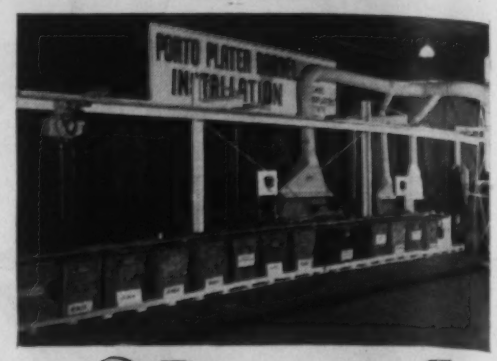
At the recent convention of the American Electroplaters Society, a paper entitled "Some Experiences in Heavy Rhodium Plating" was delivered by Harold J. Wiesner, of the Bendix Aviation Corp.

Rhodium is a hard metal with the color of platinum and exceptional corrosion resistance. Its high melting point and fair electrical conductivity are also properties of interest. Combinations of these properties suggest uses in the jewelry trade, jet and rocket propulsion, scientific instruments, electrical contacts, and the atomic energy program.

Deposits of rhodium are highly stressed, and very effective cleaning and etching of the basis metal are required. Suitable techniques are described, and emphasis is given to the desirability of employing nickel undercoatings.

Many aspects of the operation of the rhodium sulfate-sulfuric acid bath were investigated in detail. A metal concentration of 8-16 g/1 was found to be satisfactory. The initial

20,000 Experts Admire the Finish AND the Tanks!



Educational Exhibit shows advantages of

LUSTER-ON® and PLA-TANK®

All over the Industrial Finishing Exposition at Chicago, the two big words were LUSTER-ON and PLA-TANK. In the Electroplaters' Institute demonstration shown above a complete zinc barrel-plating line turned out these license plate nuts and bolts by the thousand — all brilliantly finished with long-lasting, corrosion-resisting LUSTER-ON dip.

LUSTER-ON is the original passivating bright dip introduced in 1944 by The Chemical Corporation. Since then it has been adopted by many of the leading industries of the country on such items as auto parts, aircraft parts, hardware items, wire goods, television components, electrical parts, tools, etc. Every day former users of nickel and cadmium are converting to this passivating bright dip.

Naturally the tanks, hoods and duct work were all PLA-TANK Resin-Bonded Fiberglas®, the amazing new reinforced plastic material which resists most plating solutions, acids, dips and rinses. PLA-TANK is the pioneer in this field, designed and built by metal finishing men for metal finishing use.

Send for free data sheets on Luster-On and Pla-Tank and set of license plate bolts shown.

THE Chemical CORPORATION
67 Waltham Avenue, Springfield 9, Mass.

Steel tanks? No... PLASTIC because they outlast steel 10 to 50 times!

Battered by sandstorms, baked by desert sun, attacked by desert night dampness . . . steel fuel tanks on Arabian-American Oil Company trucks wore out fast. Replacement costs were terrific.

Aramco sought a better, longer-lasting material. Result: new tanks of Cyanamid's LAMINAC® Resin reinforced with Fiberglas mat.

Advantages: . . . the new LAMINAC tanks are really corrosion-resistant, outlast steel 10 to 50 times.
. . . LAMINAC's light weight permitted two 1000-gallon tanks weighing 1000 pounds each to replace one 2300-pound steel tank holding only 1500 gallons.
. . . repairs can be made quickly *on the spot* with LAMINAC-impregnated Fiberglas mat, contrasted with expensive draining, cleaning and welding required for steel tanks.

LAMINAC'S great strength, light weight, excellent electrical properties, molded-in color and resistance to water, heat and chemicals, have solved countless problems. It has been used successfully for aircraft parts, automobile bodies, translucent panels, fishing rods, skis, housings, helmets, fragment-proof vests and hundreds of other applications.

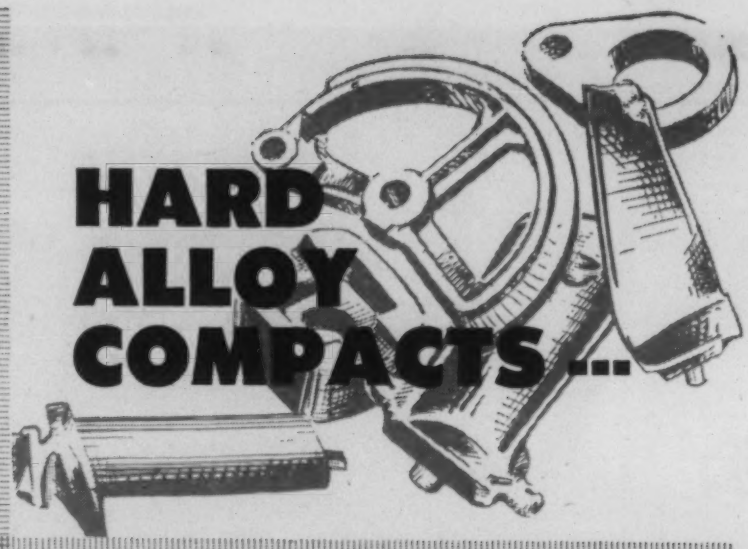
Perhaps LAMINAC is the material to answer your problem. We'll gladly help you find out.

AMERICAN Cyanamid COMPANY
PLASTICS DEPARTMENT
34M Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Royal Bank Building, Toronto, Ontario, Canada

We may be able to help you meet military specifications where plastics and resins are concerned. What's your problem?

For low cost HARD ALLOY COMPACTS...



Titanium and Zirconium Alloy Powders

. . . without the high cost and expensive equipment needed for sheet metal fabrication and bar stock for small metal and/or alloy parts, metallurgists now turn to

Titanium Metal Powder . . . Titanium Hydride
Zirconium Powder . . . Zirconium Hydride

Equal to the low cost advantage of pressing and sintering for small parts, (such as components requiring hardness, corrosion resistance, and high temperature service) are the considerations that *no waste* results when these powders or hydrides are employed. Particles are homogeneous alloys, thus insuring homogeneous products.

Available from Metal Hydrides Incorporated are powders of titanium and zirconium alloyed with Nickel; Chromium; Cobalt; Manganese; Thorium; Uranium; Tantalum; and Niobium (formerly Columbium)

Titanium hydride can be sintered under vacuum to produce Titanium metal.

Zirconium hydride can be likewise handled to produce Zirconium metal.

Save time, money, investment in equipment and machinery; and eliminate production waste by using Metal Hydrides alloy powders.

MH **METAL HYDRIDES INC.**

12-24 CONGRESS STREET • BEVERLY • MASS.

News Digest

free-acid content should be adjusted to yield reasonably constant cathode efficiency as the acid content increases owing to the use of insoluble anodes. A suitable bath may be operated as follows: rhodium as metal, 10 g/1; sulfuric acid, 125 ml/1; temperature, 49-50 C; current density, 18-20 asf; agitation, vigorous. A wetting agent, such as Orvus, is effective in reducing pitting.

Rhodium plating baths are quite sensitive to certain impurities, such as chlorides, silver, copper and mercury, but are insensitive to others, such as nickel and iron (as simple metallic ions). Many organic impurities can cause serious trouble; for example, Lucite tanks which have been assembled with cements must be baked and then leached with sulfuric acid to rid them of contaminating solvents.

A semi-production installation was described, and data on its operation reported. Variation of efficiency with operating time is a variable which must be recognized in plating to specifications.

Directions for routine control methods as well as a technique for purifying the baths were presented in detail.

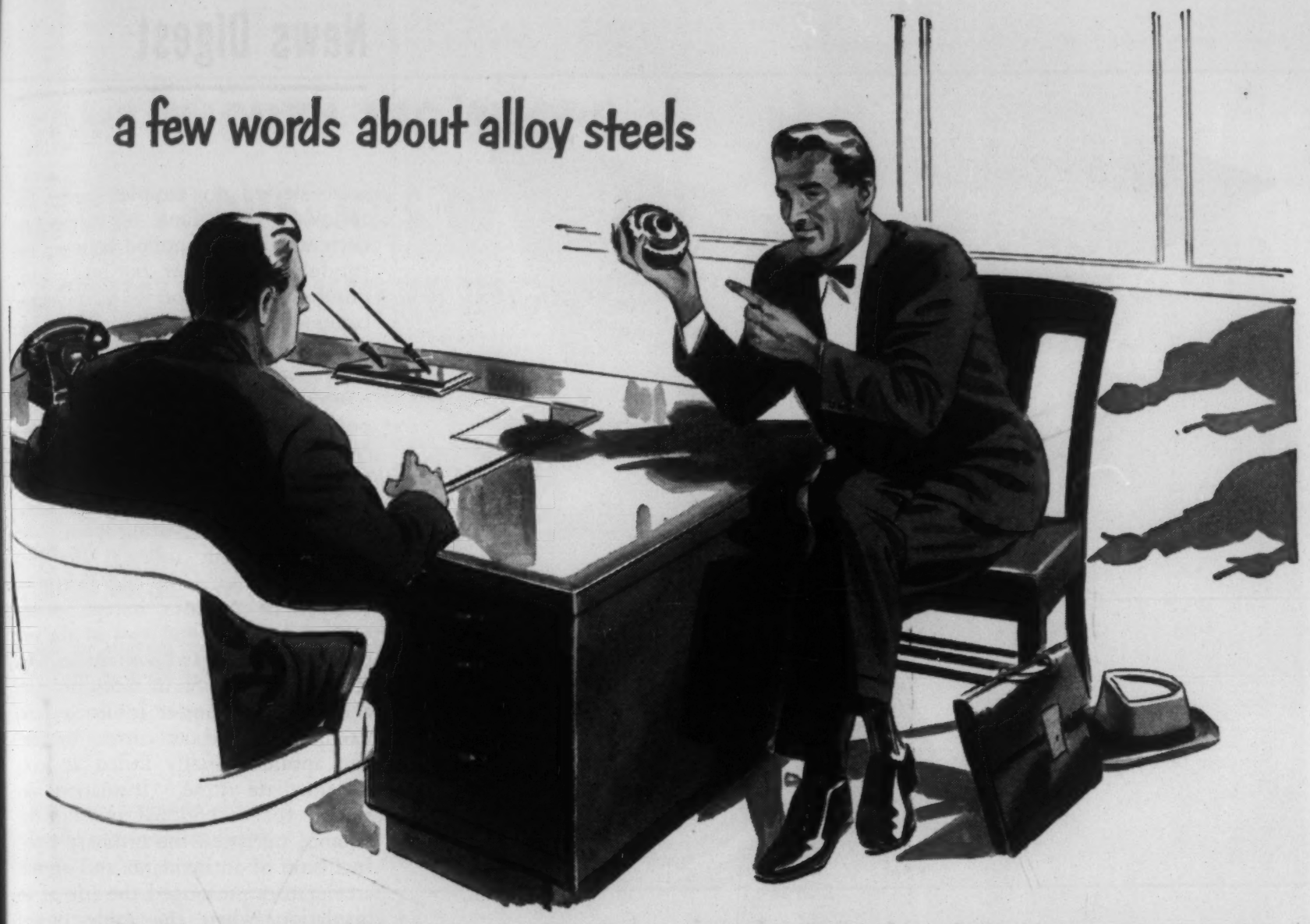
Moisture vs Rubber Insulation

An article in the *General Electric Review*, by R. B. McKinley and C. H. Seaberg, discussed the effect of moisture on rubber electrical insulation.

Although rubber compounds are used to waterproof such everyday items as overshoes, raincoats and garden hoses, rubber compounds in general cannot be considered waterproof when used as an insulation for wire and cable. Cables insulated with rubber compounds must withstand years of continual exposure with a consequent absorption of moisture.

The authors describe long-time tests that were conducted to overcome the uncertainties induced by various short run tests. These tests

a few words about alloy steels



or, where you can use Boron Steels, *we can help you*

If you are faced with the problems of allocations and shortages of the alloy steels you've been accustomed to use, you can probably make your job easier by shifting to Republic alternate grades or *boron* type alloy steels.

Republic has been producing boron steels commercially for more than 10 years. In that time we have made more tons of boron steels than any other alloy producer. Which means that we have solved more problems of shifting to boron alloys, have assembled more knowledge about the boron grades than any other producer.

Our 3-Dimension Metallurgical Service can give you the help you need to switch your production to alternate alloys or boron steels quickly and with the fewest headaches. A Republic Field Metallurgist analyzes your products and production set-up right in your plant. Then he goes over your case with the other two members of the 3-Dimension team... the Republic Mill and Laboratory Metallurgists.

The result? If the parts you are making from alloy steels are adaptable to *boron* steels, you'll get expert answers and recommendations that will speed you into boron-grade production promptly.

Boron steels aren't always the answer, may not solve every problem . . . your Republic Field Metallurgist will give you honest advice, backed by Republic 3-Dimension Metallurgical Service.

When may we call?

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

LAB FIELD MILL 3-DIMENSION Metallurgical Service

Republic ALLOY STEELS

REPUBLIC STEEL

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

• Self locating. Shank protects threads from weld splatter. No retapping.
• Round shape. No indexing in assembly. Compactness permits use on narrow flanges.
• Engineered projections. No burn-outs in thin sheets. Simple electrodes. No pilots required.

THE FIRST GREAT IMPROVEMENT IN

WELD FASTENERS

PEM Self-Locating Weld Fasteners are "common-sense engineered," based on the experience of hundreds of users of weld fasteners.

They will speed your assembly, cut equipment and labor costs and do a better fastening job, wherever load carrying threads are required in thin metals that may be welded.

Write for literature and samples for trial. Penn Engineering & Manufacturing Corp., Doylestown, Pa.

PEM

News Digest

were started on samples under the following conditions: no voltage, no current; 1500 v applied between the conductor and water, but no current; normal current (for a 140 F rubber compound in air), but no voltage. The temperature of the immersion water was held at 104 F. Eight natural rubber formulations and one polyvinyl chloride compound of an early design were chosen. They are compounds covered by standard industry specifications, along with some special moisture resisting types.

Rated current through the conductor prolonged the life of the insulation in all cases, except for the 60% submarine and two of the oil-based types. Rated voltage accelerated the absorption of moisture, with a consequent shorter insulation life. Compounds without current or voltage applied usually failed at some intermediate time. Insulation designed for exceptional moisture resistance outlasted the ordinary types. Inclusion of antioxidants and organic accelerators prolonged the life of an insulation when the cable carried rated current. The combination of good heat and moisture resisting properties proved the ideal for power cables.

Laboratory tests on polyethylene show the moisture resistance of this insulation to be the best of all. It is the ideal insulation for certain applications, such as communication cables, where the lowest electrical values and highest moisture resistance are given precedence over other considerations.

Buna-S and butyl, both thermosetting synthetic rubbers, are equal to and in many respects superior to natural rubber for use in insulation compounds. Based on General Electric tests, similarly compounded insulations of either Buna-S or natural rubber show generally parallel results. Butyl rubber made possible an ozone-resisting compound having exceptional moisture and heat resistant properties, plus good electrical characteristics and aging ability.

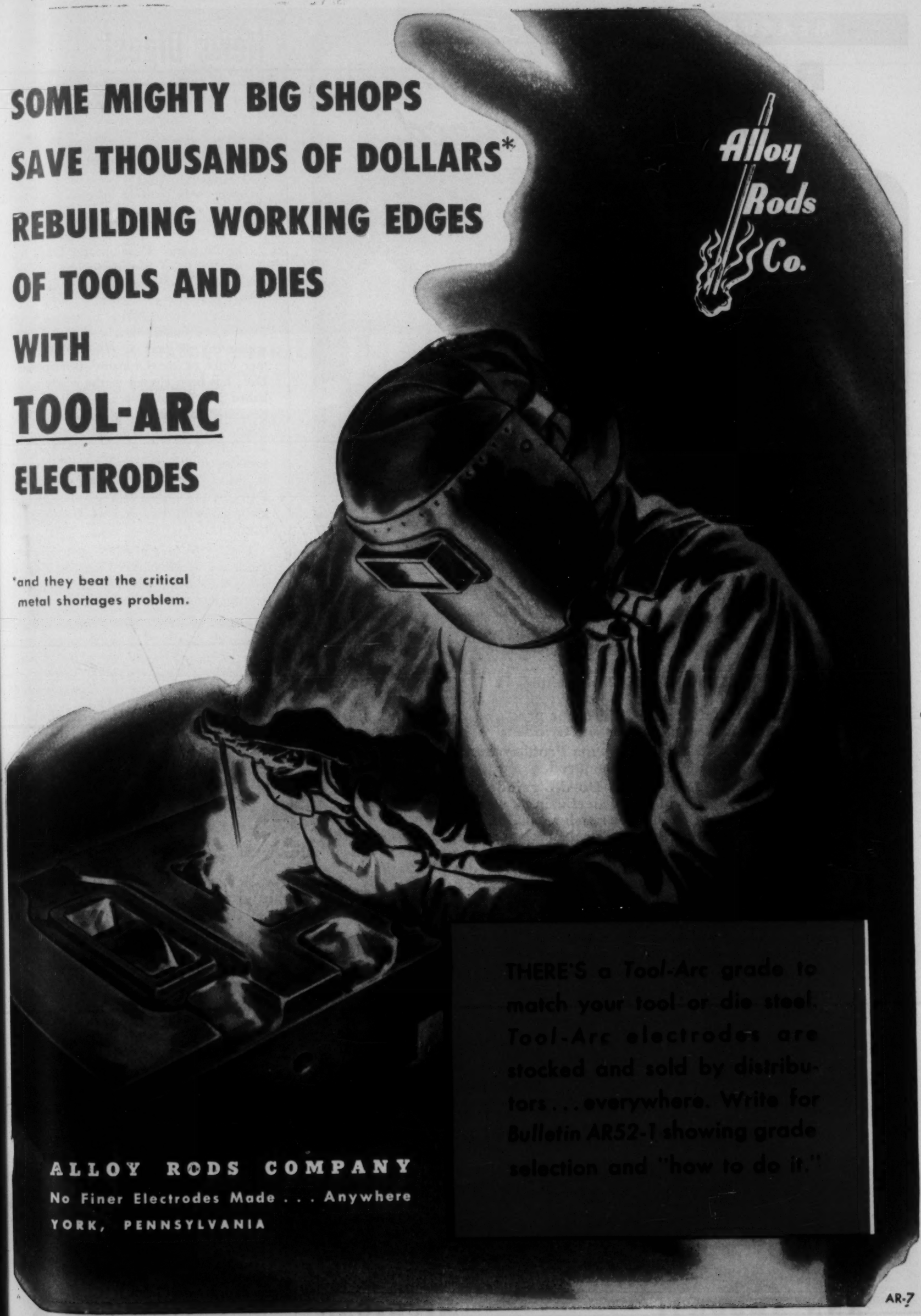
News of Engineers

Carl A. Salmonsen has been named acting general manager of General Elec-

(Continued on page 212)

SOME MIGHTY BIG SHOPS SAVE THOUSANDS OF DOLLARS* REBUILDING WORKING EDGES OF TOOLS AND DIES WITH TOOL-ARC ELECTRODES

*and they beat the critical metal shortages problem.



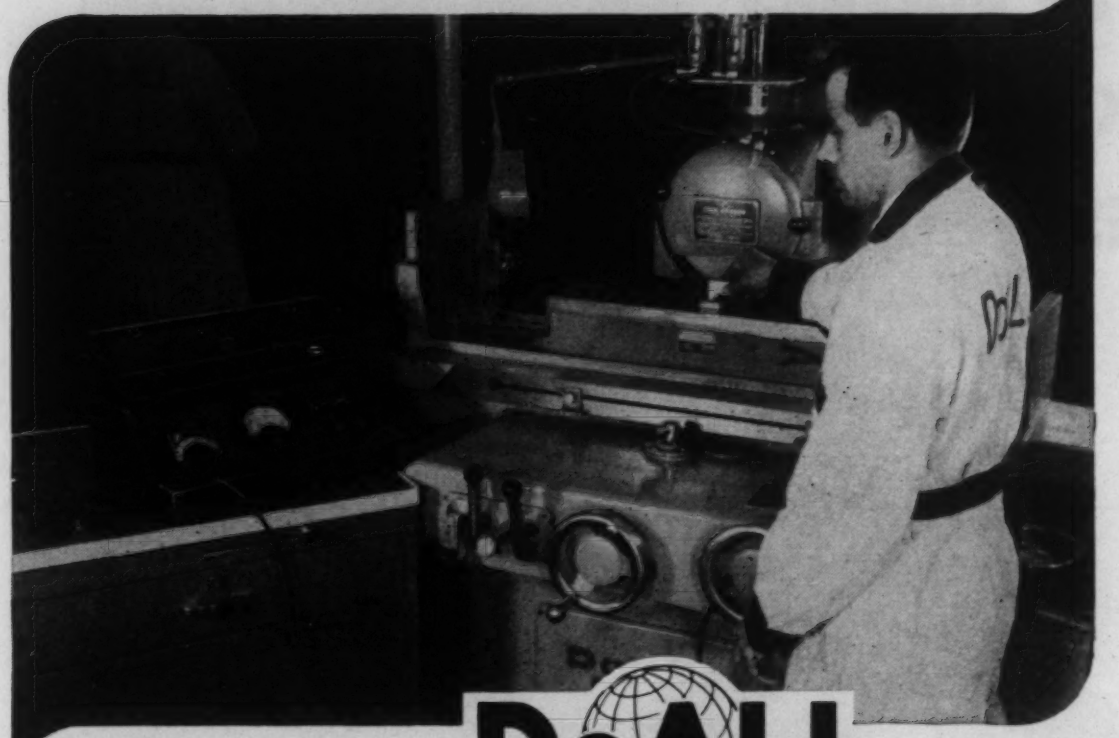
THERE'S a *Tool-Arc* grade to match your tool or die steel. *Tool-Arc* electrodes are stocked and sold by distributors . . . everywhere. Write for *Bulletin AR52-1* showing grade selection and "how to do it."

ALLOY RODS COMPANY
No Finer Electrodes Made . . . Anywhere
YORK, PENNSYLVANIA

AR-7

MEASURE IN MICROINCHES RMS

Precise Surface Finishes *assured*



because DoALL uses the PROFILOMETER

The DoALL Company of Des Plaines, Illinois, world famous manufacturer of machine tools, gages and cutting tools, gives customers an exclusive analysis of the precision and dependability of each DoALL Precision Surface Grinder.

To do this, DoALL relies on the Profilometer as the final check made on every grinder manufactured.

Rigid tests provide that each DoALL grinder before completion must grind a sample block of steel using a standard 46-grit wheel and have the resulting surface finish measured by the Profilometer. This Profilometer test on the steel block must register a finish of less than 10 microinches r.m.s.! These records of surface finish with the actual steel block are then attached to each grinder prior to shipment—thus assuring purchasers of the exceptional precision of each grinder.

As a shop instrument the Profilometer is widely being used throughout all industry where surface measurement is needed in machining, grinding or other sizing and finishing operations.

The Profilometer provides the fastest, simplest and most versatile means of obtaining dependable roughness ratings for all surfaces from a fraction of a microinch to 1000 microinches r.m.s.

In your plant, too, the Profilometer can offer exceptional advantages as an all important shop tool.

To learn how the Profilometer can help cut costs in your production, write today for these free bulletins.

***Profilometer* is a registered trade name.**

MICROMETRICAL MANUFACTURING COMPANY
formerly PHYSICISTS RESEARCH COMPANY
Instrument Manufacturers
ANN ARBOR 14 MICHIGAN

News Digest

tric Co.'s Control Dept. at Schenectady. Mr. Salmonsen replaces *Karl R. Van Tassel,* who was recently appointed general manager of the Knolls · Atomic Power Laboratory, Operating Dept.

The Ordnance Development Div., National Bureau of Standards, has been reorganized into three new divisions and three new division heads have been designated. In addition, an associate director for ordnance development has been appointed. *Wilbur S. Hinman, Jr.,* former chief of the Ordnance Development Div., has been elected to the newly established position of associate director. The three divisions and their chiefs are: Division 13, Ordnance Development Program A, with *M. G. Domsitz* as chief; Division 16, Ordnance Development Program B, with *Jacob Rabinow* as chief; and Division 17, Ordnance Development Program C, with Dr. *Harold Goldberg* as chief.

Walter J. Lee, assistant general manager of the Goodyear Tire & Rubber Co.'s Rim Div., has been promoted to general manager of the Division.

Rodney Hunt Machine Co. has recently added *Norman D. Sixt,* technical engineer, *William H. Bosworth, Jr.,* chemical engineer, and *Calvin L. Rasmussen,* food technologist, to the technical staff of the company's Process Equipment Div.

Dana L. Mock, atomic physicist, has joined the staff of Atlantic Research Corp. to work with the firm's Solid Propellent Group. Previously, Mr. Mock worked on atomic energy projects and the betatron project at the Naval Research Labs.

Hooker Electrochemical Co. has announced the following new appointments to its engineering department. Dr. *Eugene T. Miller* and *Alfred W. Toon.*

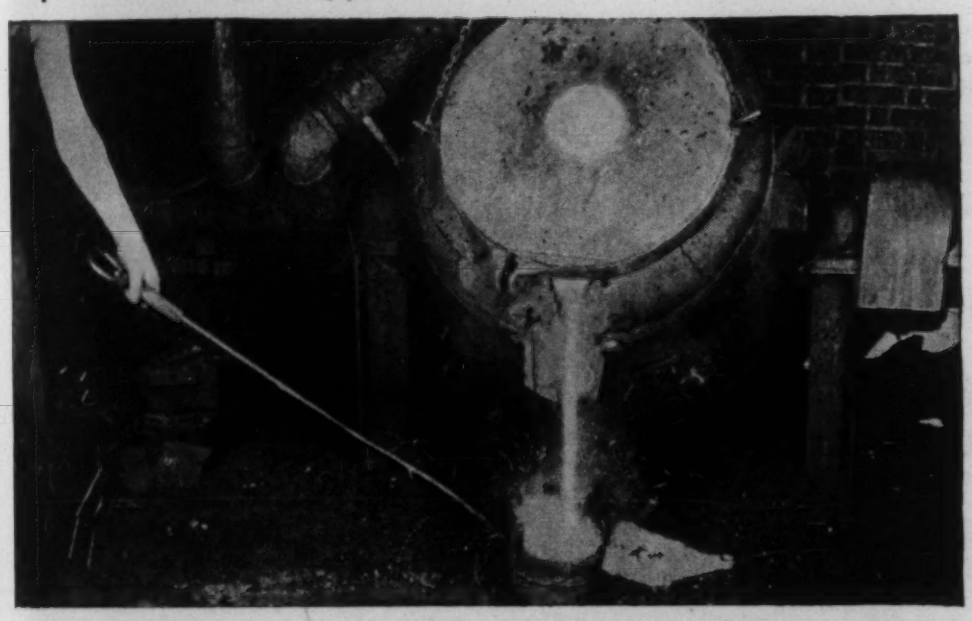
William A. Sipprell, Jr., chairman of the board and president of H. & B. American Machine Co., has become president of Cleveland Welding Co. Mr. Sipprell succeeds *Harry W. Kranz,* who has retired after serving as president since 1926. Mr. Kranz continues as a director of the firm.

At a recent meeting of the board of Taylor Fibre Co., *John M. Taylor,* president, was elected chairman of the board. *Merritt H. Taylor,* a company director, was elected president and *Clifton N. Jacobs* was elected vice president in charge of research and engineering.

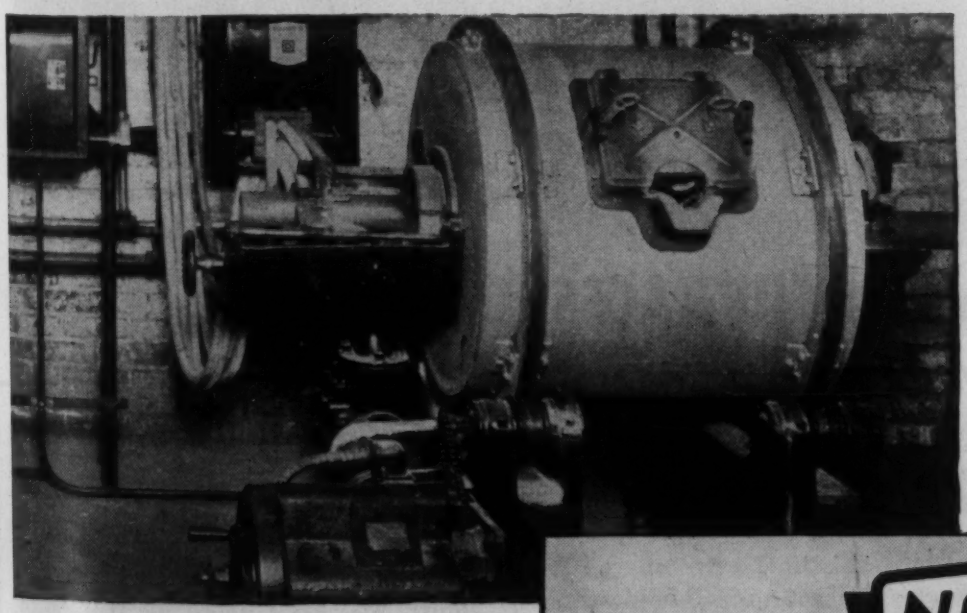
The return of Dr. *T. J. Jaramillo* to the Engineering Mechanics Div. of Armour Research Foundation, Illinois Institute of Technology as senior scientist has been announced.

Four members of the plastics department of Dow Chemical Co. have been named to key positions. Dr. *William H.*

THIS REVERBERATORY FURNACE is lined with a Norton CRYSTOLON* refractory cement, engineered to last longer on this particular metal-melting job.



THIS TILTING CRUCIBLE FURNACE has a cover and lining made of a Norton CRYSTOLON refractory cement. It was engineered to fit this firm's individual requirements.



THIS INDIRECT ARC FURNACE owes much of its high output to its lining, made of a custom-engineered Norton ALUNDUM* refractory cement.

Melt more metal per furnace-hour

with refractory linings engineered for you

Every time you interrupt your metal-melting campaigns to patch or replace your furnace linings, you lose production you never get back.

That's why just *any* refractory cement won't do. You want the *one* cement that fits your requirements so exactly that it reduces interruptions to a minimum. Chances are, the one just-right cement hasn't been made yet.

That's where your nearby Norton refractories engineer enters your picture. He's ready to call on Norton Research . . . pioneers for 40 years in the development of special refractories for complicated high-temperature requirements.

Working together, you and Norton Company are sure to arrive at the one CRYSTOLON, ALUNDUM, MAGNORITE* or FUSED STABILIZED ZIRCONIA refractory cement that fits your exact requirements.

For more information about this special Norton service, call your nearby Norton refractories engineer, or write Norton Company, 345 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Marks Reg. U. S. Patent Office and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

When heavy, unwieldly weldments like these diesel crankcases can be quickly swung into any position so that every weld is made *downhand* —that's efficient welding!

Welders spend more time welding—do better welding at lower cost when they work with C-F Positioners because these hand and/or power operated machines reduce positioning time to a minimum. Investigate the cost-saving advantages of C-F Positioners. They pay their way in any company.

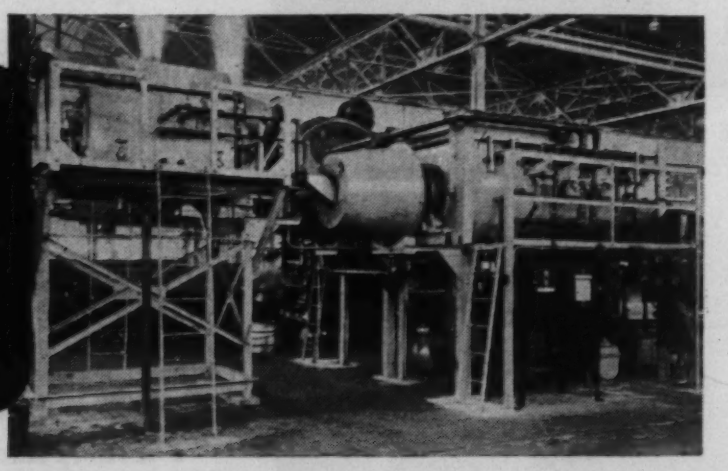
Write for Bulletin WP26 — an illustrated circular detailing the *Specific* advantages of C-F Positioners.

CULLEN-FRIESTEDT CO.
1314 S. Kilbourne Ave., Chicago 23

CULLEN-FRIESTEDT CO., CHICAGO 23, ILL.

C-F positioned welds mean better, more economical welds

For Continuous Automatic Heating with Control of Heating Rate and Product Uniformity



ROCKWELL *Revolving Retort* FURNACES

Offer Many Advantages

For annealing, hardening and drawing small ferrous or non-ferrous metal parts which may be slowly tumbled during slow helical progression through the retort, this Rockwell Furnace exposes all pieces at the same heating rate and time under controlled conditions of temperature and atmosphere.

Work may be bulk fed from washing machines or hoppers and discharged into cooling, pickling, cleaning or other processing equipment, without manual handling — in minimum space and without interfering with other operations.

Furnaces may be gas- or oil-fired or electric. Available in 4 standard sizes for 300, 800, 1500 and 1800 lbs. of metal heated per hour. Special sizes to order. Write for Bulletin 424R.

Rockwell also builds batch and continuous types of furnaces and ovens; strip and wire cleaning and reeling equipment; handling and special equipment.

W. S. ROCKWELL COMPANY
208 ELIOT STREET • FAIRFIELD, CONN.

News Digest

Schuette has been appointed manager of the newly-formed Plastics Production Dept. Responsible to Dr. Schuette will be *Max Key* as manager of saran production. *Earl L. Collins* has been named manager of polystyrene production, and *Albert T. Maasberg* is the new manager of cellulose products production.

Allied Products Corp. has announced that *Ralph Hubbart,* president since 1928, has been advanced to chairman of the board. *Frank H. Bishop,* who has been executive vice president, was elected president as well as director.

Raymond C. Platow, formerly of Bell Telephone Laboratories, has joined the research and development staff of United States Plywood Corp. as chief materials engineer.

The board of directors of General Mills has elected *Charles H. Bell,* executive vice president, as president of the corporation. Mr. Bell succeeds *Leslie N. Perrin,* who submitted his resignation after attaining retirement age. Mr. Perrin will continue as a member of the board. *A. C. Hopkins, Jr.* has been appointed director of commercial chemical development at General Mills Research Laboratories. Mr. Hopkins was formerly with the American Maize Products Co. In his new position he will be in charge of market research and market evaluation of company chemical products such as Polyamide resins, fatty acid amines and allyl starch.

Bennett D. Jones, metallurgist at Standard Pressed Steel Co., has been made manager of product development. Named to succeed Mr. Jones was *Robert L. Sproat,* an assistant in the department since 1948.

P. R. Mallory & Co., Inc. has elected *Frank B. Powers* to the office of vice president in charge of manufacturing.

Appointment of *Chester L. Shaw* as works manager of the Detroit Broach Co. has been announced.

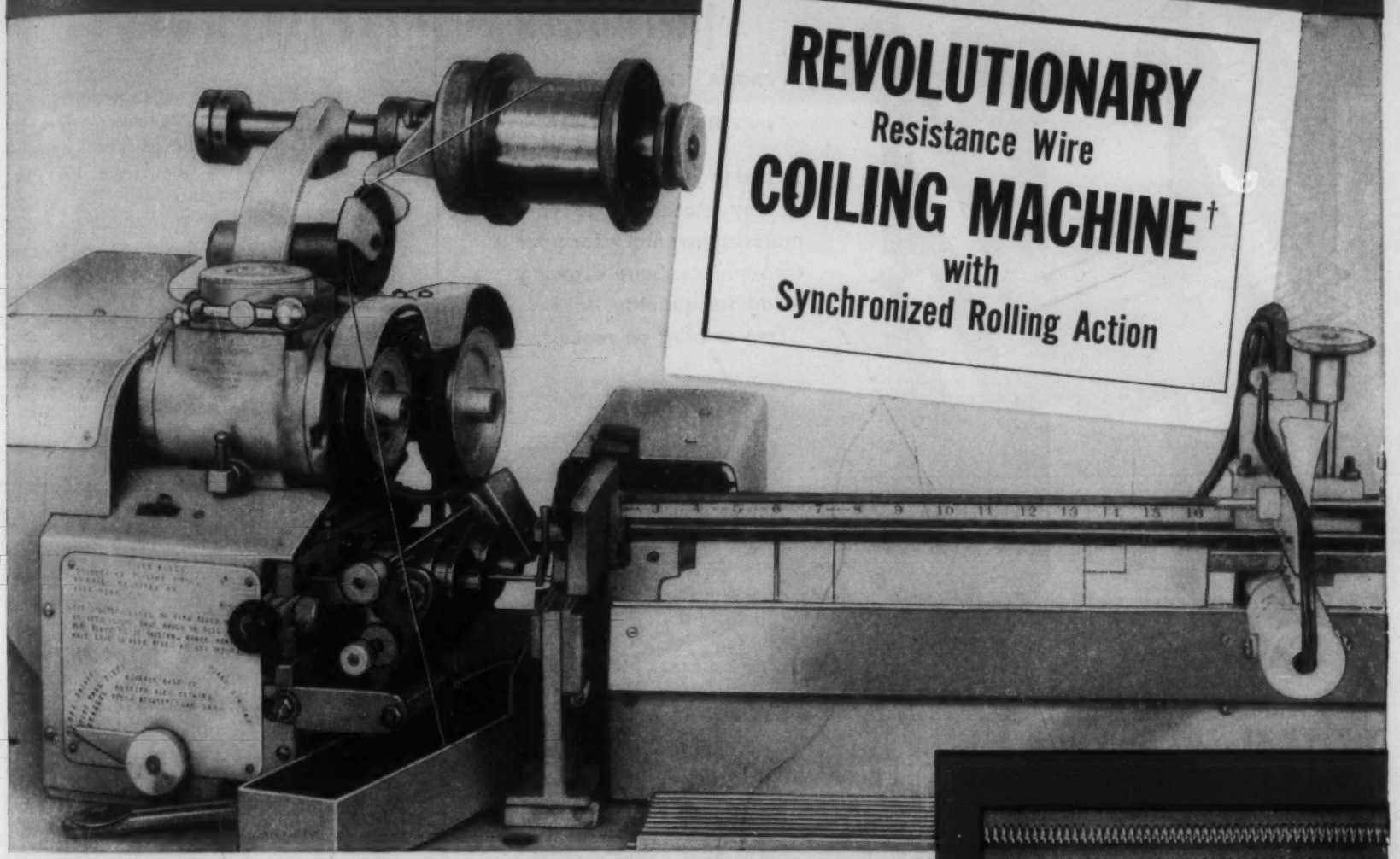
Wallace L. Howe has been appointed director of research and development at Norton Co., following the resignation of Dr. *Samuel S. Kistler.* Formerly director of development, Mr. Howe now heads the activities of both departments.

James E. Edelbrock has been appointed manager of the Chicago factory branch of Gar Wood Industries. He replaces *Ross Miller,* who has assumed the position of vice president and general manager of National Lift Co., a subsidiary of Gar Wood.

Appointment of *E. J. Burnett* to the engineering staff of Revco, Inc. has been announced.

Dr. *Gilbert E. Doan,* nationally-known metallurgist and author on metallurgical subjects, has joined the research department of Koppers Co. as manager of the

DRIVER-HARRIS ANNOUNCES . . .



As producers of the world famous "Nichrome"* and other outstanding electric heating and resistance alloys, Driver-Harris engineers are interested in obtaining application results commensurate with the exceptional advantages their alloys afford. Therefore they have developed a new coiling machine which eliminates wire coiling faults—especially coil irregularity due to work-hardened areas produced during coil formation.

This new machine is the result of knowledge accumulated during forty years of close association with wire coiling problems. Its revolutionary principle of operation—*the synchronized rolling action of all coiling parts*—results in vastly improved performance over that of any other type machine.

Product of long study and a thorough knowledge of the requirements of the industry, this Driver-Harris unit—

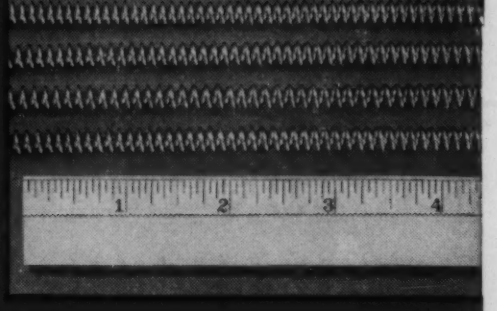
(1) handles the full range of resistance wire coiling normally required, close or open winding (and can be adapted for twin wire coiling);

(2) cuts coil ends clean on all sizes, close or open wound;

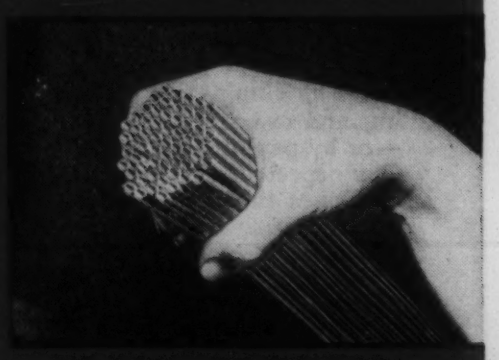
(3) maintains resistance accuracy of cut coils at all times by photo-electric control (variation not exceeding ± 1%);

(4) affords the lowest operational and maintenance costs of any comparable coiling machine.

Standard Model coils #20 to #36 B&S gauge wire. Units for other gauges built to order. Send for illustrated Bulletin C-52, giving full information.



Note even spacing between turns of stretched coils.



Coil ends lie *flat*. No burring or twisting of wire.

*T.M. Reg. U.S. Pat. Off.
†Patent Pending

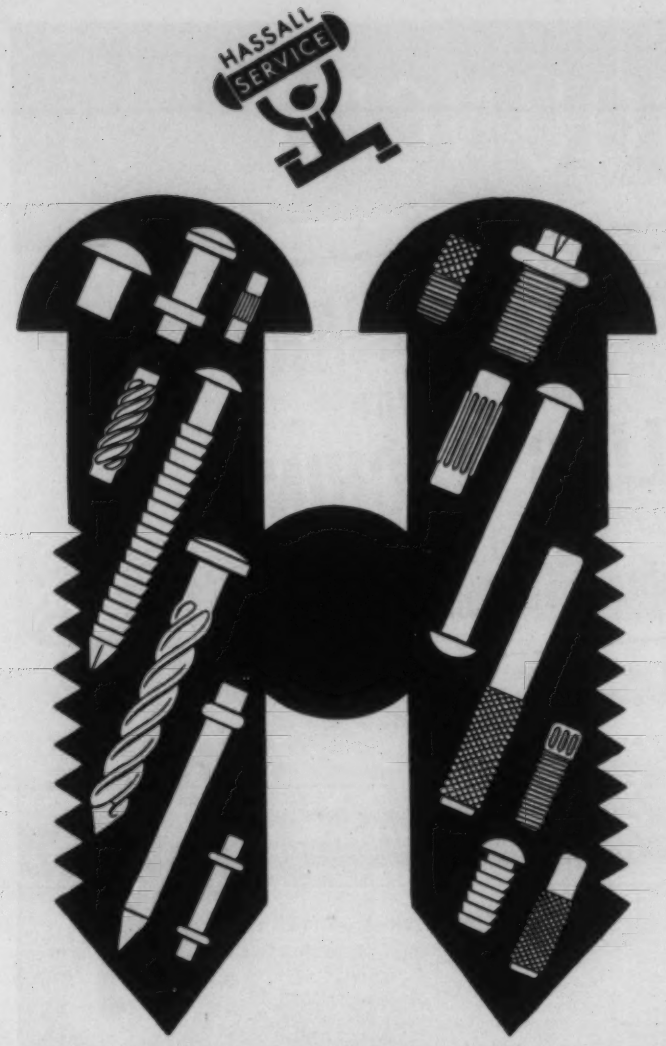
SPECIAL PURPOSE ALLOYS SINCE 1899 — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD



Special cold headed products

. . . nails · rivets · screws

. . . made to order

. . . and to your specifications in any metal. Large raw material inventory for your convenience. Send drawing — advise quantity.

Free catalog on request.

SPECIAL NAILS RIVETS SCREWS
Hassall
ESTABLISHED 1850

JOHN HASSALL INC.

162 Clay Street
Brooklyn 22, New York

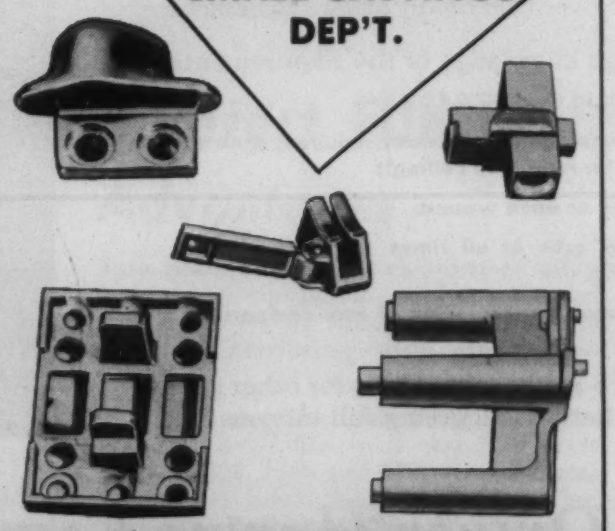
Save! Small Metal Parts Now Die-Cast Automatically

in

DOLLIN'S
SMALL CASTINGS DEP'T.

SMALL Zinc Die Castings 1000 per lb. to 3 per lb.*

SAVE by eliminating machining and assembly operations —or by paying less per piece. Our specialized equipment combines the design latitude of die-casting with the speed of fully automatic processes! Check with us on consolidating simple parts, or on cutting costs of any of your small parts requirements. Parts are delivered completely trimmed– and, when desired, ready for use.



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*Approx. range for Small Castings Dep't.

DOLLIN CORPORATION

Zinc & Aluminum Die Castings in All Commercial Sizes

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News Digest

metallurgical branch. *W. D. Levie,* production superintendent at the St. Paul coke plant, has been appointed technical adviser to the plant manager. *Jess H. Brown* succeeds Mr. Levie. The Company has also announced that *John W. Pennington,* chief engineer of the Piston Ring Dept., has been named executive engineer and head of the newly created Technical Dept. of Koppers Metal Products Div.

M. P. Nordell, vice president and treasurer of Rockford Drop Forge Co., has been elected president of the Drop Forging Assn. *Raymond G. Sault,* president, Porter Forge & Furnace Inc., was named vice president.

John D. Judge has been appointed president of Tube Reducing Corp. to succeed the late *J. J. White.*

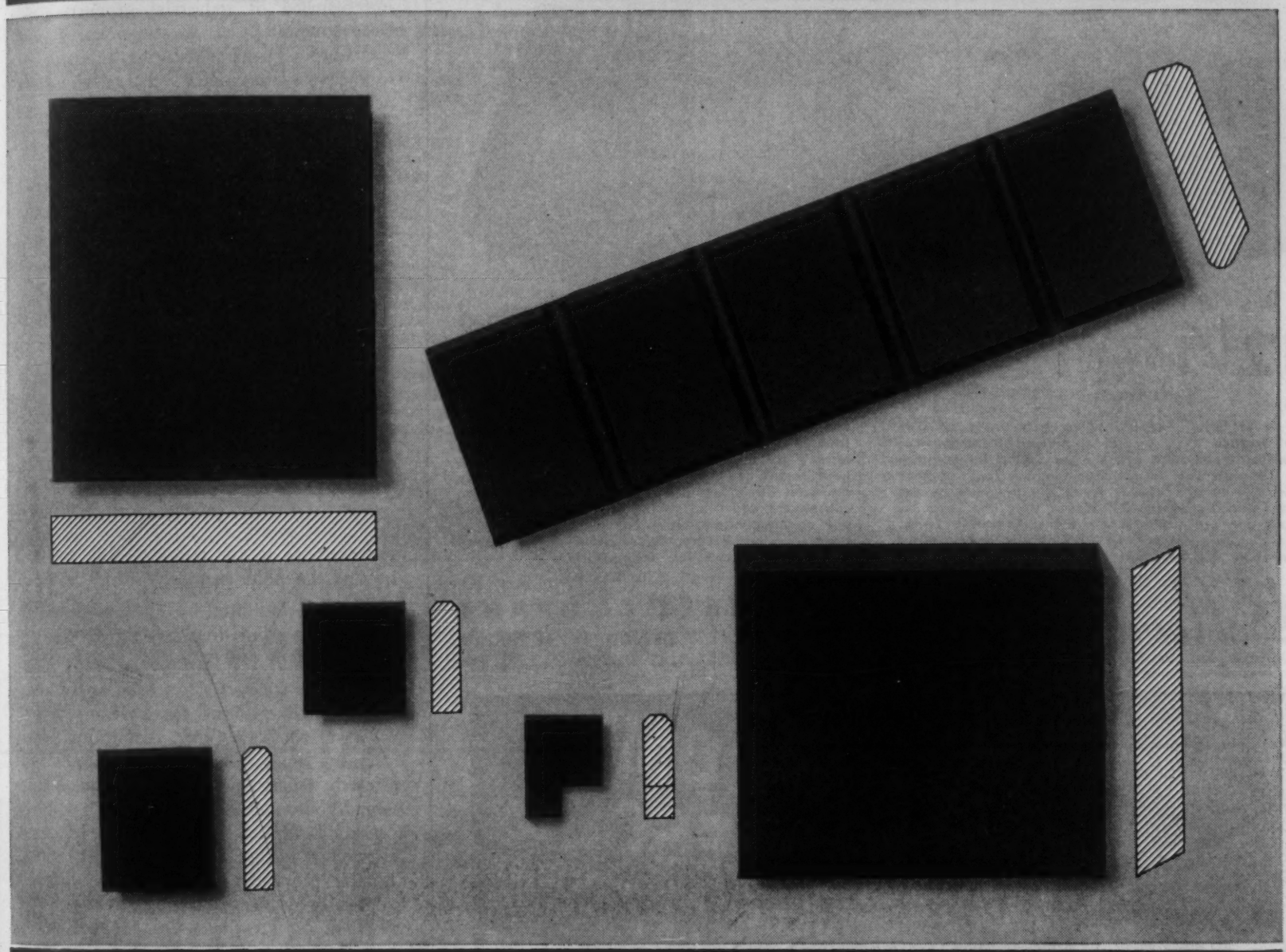
A corporate change has taken place in the Vonnegut Molder Corp. with the retirement of *Anton Vonnegut.* The business of the Company has been taken over by its present personnel and will be known as the Grinding and Polishing Machinery Co. Officers are: *R. W. Smart,* president; *O. S. DeHaven,* vice president; *I. W. Bosworth,* secretary and treasurer. Mr. Vonnegut will continue to serve as a member of the board.

American Cyanamid Co. has announced that *John F. McGreevy* has joined the Central Engineering Dept., where he has been assigned to a study of the program for X51, the Company's new acrylic fiber. Mr. McGreevy will be special assistant to the chief engineer. *C. B. Clark,* director of the Patent Dept. of the Company's Stamford research laboratories, has retired after 23 years of service with the Company. *Palmer W. Griffith,* technical service director-West Coast, of the Company, received the 11th annual John Wesley Hyatt Award "for achievement of wide importance to the plastics industry".

To coordinate its product development and research activities under a planned, overall company program, Anaconda Wire & Cable Co. has created a new Research Dept., to include the Engineering Laboratories at Hastings; the Magnet Wire Research Laboratory at Muskegon; and the Rubber Products Development Laboratory at Marion. The new director of research for the company is *H. E. Thompson,* formerly manager of quality control. *E. L. Gittleson* will succeed Mr. Thompson as manager of quality control. Product development activities of the company will be guided by a research and development committee recently formed. Its members include: *L. F. Hickernell,* chief engineer; *D. E. Allen,* sales manager; *R. B. Steinmetz,* general manager of mills; with Mr. Thompson as chairman.

Metal & Thermit Corp. has announced

For Superior Pump Performance... Specify NATIONAL TRADE-MARK Carbon Rotor Vanes



ACCURATE FINISH • LOW FRICTION • DIMENSIONAL STABILITY • MECHANICAL STRENGTH •
HEAT RESISTANCE • SELF LUBRICATING • WEAR RESISTANCE • CORROSION RESISTANCE

LOW LIGHT BILLS...
mark phenomenal acceptance of "EVEREADY" No. 1050 Industrial Flashlight Batteries by a broad cross-section of industry. Delivering twice the usable light of any battery we've ever made before, it will not swell, stick or jam in the flashlight . . . has no metal can to leak or corrode.

● "National" Carbon Rotor Vanes for pumps and compressors are precisely machined and finished from a special carbon-base material which provides a combination of properties unmatched by any other kind of material for this service.

Precision machined to your blue-print specifications, "National" Rotor Vanes are your answer to tough operating problems such as corrosive liquids and gases, high temperatures, case-galling, warpage and other sources of frequent and costly maintenance.

Engineering assistance in the design and the application of "National" Rotor Vanes is available through our district offices listed below.

The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

DISTRICT SALES OFFICES: ATLANTA, CHICAGO, DALLAS, KANSAS CITY, NEW YORK
PITTSBURGH, SAN FRANCISCO
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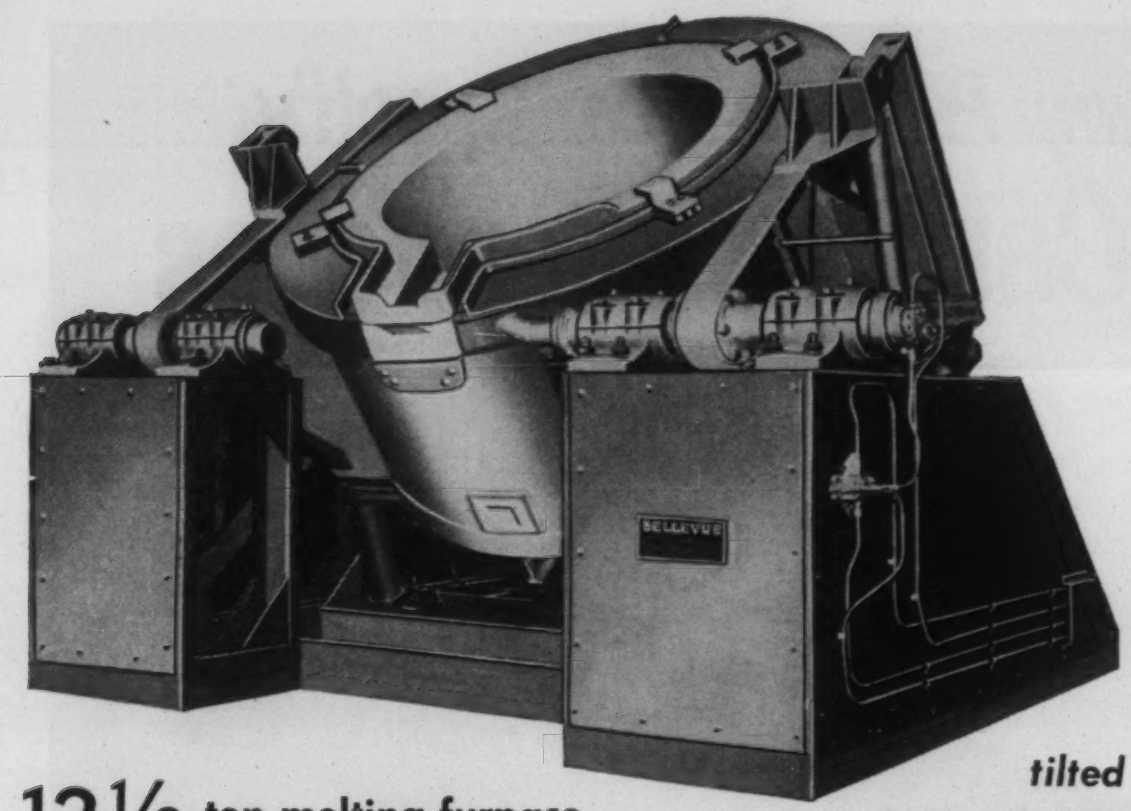

12½-ton melting furnace ***tilted hydraulically***

A lever handle control valve is mounted on side of furnace . . . metal is heated by means of burners mounted below the pot, firing tangentially to the internal lining. This gives a uniform heat distribution and avoids flame impingement on the pot, contributing to longer pot life. Unit may be built for gas, oil, or gas-oil combination firing. . . . Venting out the hot gases takes place between the pot and the refractory ring at the top of the furnace. The internal lining of the furnace is made from first quality fire brick, backed up with sufficient insulation, to minimize heat losses. The large capacity allows a single pour to fill a complete mold, thus eliminating subsequent pours. . . . The large diameter of the pot opening allows charging of large pieces of metal. . . . Pot size: 76″ diameter by 37″ deep . . . *send for complete information.*

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2622 CRANE AVENUE • DETROIT 14, MICHIGAN

PROMET COMES
TO THE RESCUE
TEMPORARY LUBRICATION FAILURES
NEEDN'T BE EXPENSIVE
Medium and High-Lead
PROMET
THE Engineered BRONZE
BRONZES
#1, #2-S, #6, #6-SK, carry on until lubrication can be restored.
Hard and strong enough to take the constant pounding of heavy shock loads and high compressive forces, these Promet Bronzes are also sufficiently high in lead content, soft enough, to prevent seizure and to embed harder particles that would ordinarily result in scoring. Easily machined at high speeds without lubricants or coolants.
Write today for service data sheets and quotations.
THE AMERICAN CRUCIBLE PRODUCTS CO.
1325 Oberlin Avenue • Lorain, Ohio, U.S.A.

News Digest

the appointment of *Herbert E. Hirschland* as director of research.

Appointment of *J. C. Fink* as engineering manager of industrial products has been announced by Westinghouse Electric Corp. Mr. Fink, formerly assistant to the vice president in charge of engineering, will coordinate the engineering activities of all the Industrial Products Divs.

Paul Porterfield has been appointed chief engineer of The Method X Co., an affiliate of Firth Sterling Inc.

The Damascus Tube Co. has announced the appointment of *Grant H. Mackay, Jr.* as chief engineer. Previously, Mr. Mackay served as welding engineer for the Cadillac Cleveland Tank Plant, and was also associated with the Steel and Tubes Div. of Republic Steel.

Robert S. Lynch, president of the Atlantic Steel Co., was recently honored with the American Society for Metals, Georgia Chapter's annual Metalworking Southeast award in recognition of his contributions to the metalworking industry and the ASM chapter.

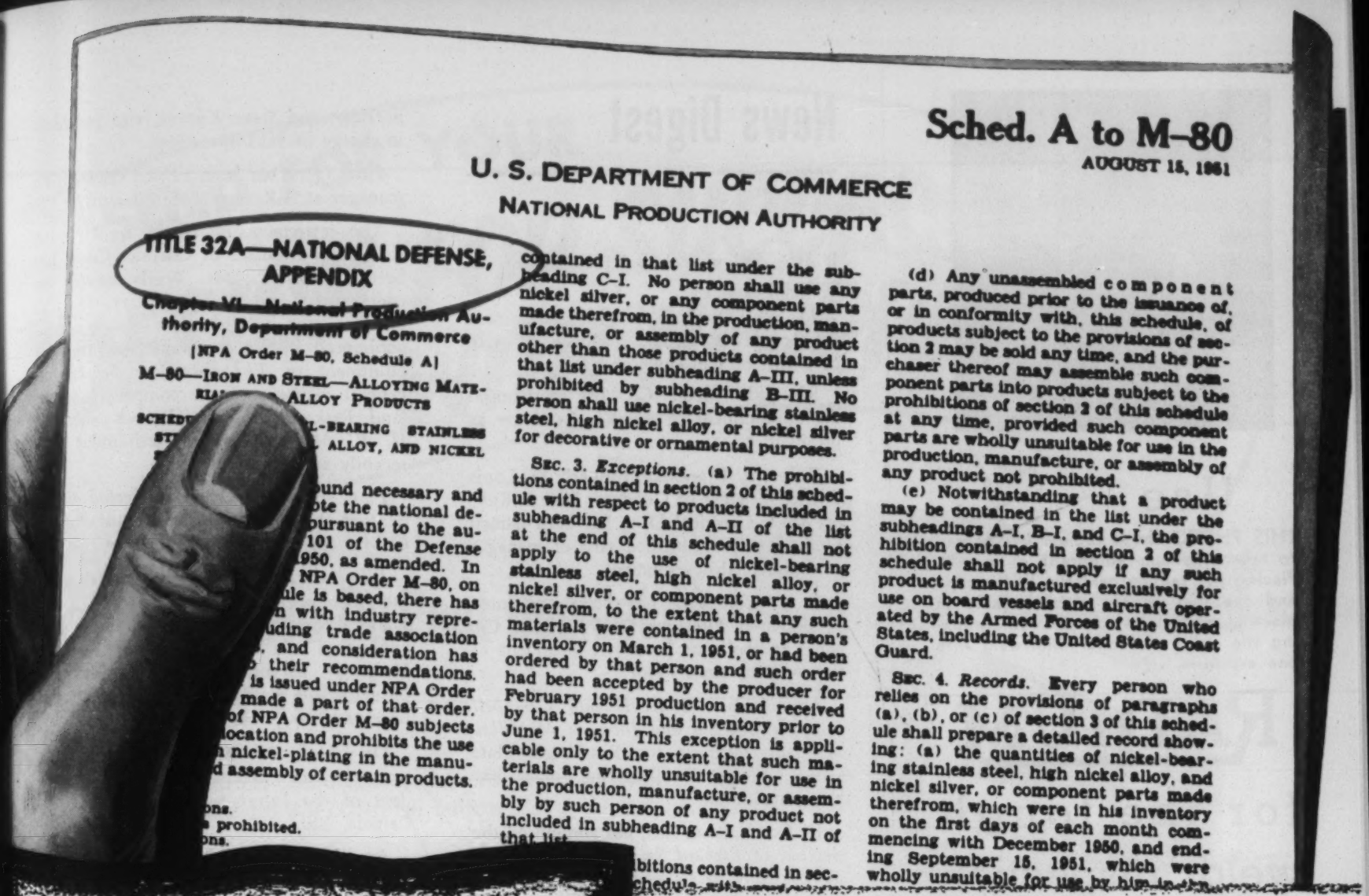
Boonton Molding Co. has announced the election of *William Turner Stopford* to the post of vice president.

Elmer L. LaGrelius has been appointed chief metallurgist of Pennsylvania Precision Casting Co. Mr. LaGrelius was formerly supervising metallurgist of the research laboratories of American Steel Foundry Co. and Armour Research Foundation. *Jack O. Trimble* has been elected director of research for the company. Mr. Trimble previously served as special consultant on casting, tooling and plastic problems for Prosthetic Co., Hughes Aircraft Co. and American Molding Co. The new sales manager for the company is *James E. Granger* who formerly held the position of sales manager of Alloy Precision Casting Co.

E. G. Bailey, founder and president of the Bailey Meter Co. and director and consultant of Babcock & Wilcox Co., was presented with the Distinguished Service Award of Ohio State University for his contributions to the engineering profession and for his work in the engineering manpower field.

The following promotions have been announced by Wellman Bronze & Aluminum Co.: *Edward C. Eizember,* who has served as chief inspector at both the Peerless and the Superior plant, has been appointed superintendent of the Peerless Plant; *Robert A. Thomas,* superintendent of the Peerless Plant, has been moved into management of the company's new Garfield plant.

At a special meeting of the board of directors of Macwhyte Co., *George C. Wilder* was appointed a director to fill the unexpired term of the late *Jessel S.*



Sched. A to M–80

AUGUST 15, 1951

U. S. DEPARTMENT OF COMMERCE

NATIONAL PRODUCTION AUTHORITY

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority, Department of Commerce

[NPA Order M–80, Schedule A]

M–80—IRON AND STEEL—ALLOYING MATERIA[illegible] ALLOY PRODUCTS

SCHED[illegible]L-BEARING STAINLESS ST[illegible] ALLOY, AND NICKEL [illegible]

[illegible]ound necessary and [illegible]ote the national de[illegible] pursuant to the au[illegible] 101 of the Defense [illegible]950, as amended. In [illegible] NPA Order M–80, on [illegible]ule is based, there has [illegible]n with industry repre[illegible]uding trade association [illegible], and consideration has [illegible] their recommendations. [illegible] is issued under NPA Order [illegible] made a part of that order. [illegible] of NPA Order M–80 subjects [illegible]location and prohibits the use [illegible]n nickel-plating in the manu[illegible]d assembly of certain products.

[illegible]ons.

[illegible] prohibited.

[illegible]ons.

contained in that list under the subheading C–I. No person shall use any nickel silver, or any component parts made therefrom, in the production, manufacture, or assembly of any product other than those products contained in that list under subheading A–III, unless prohibited by subheading B–III. No person shall use nickel-bearing stainless steel, high nickel alloy, or nickel silver for decorative or ornamental purposes.

SEC. 3. *Exceptions.* (a) The prohibitions contained in section 2 of this schedule with respect to products included in subheading A–I and A–II of the list at the end of this schedule shall not apply to the use of nickel-bearing stainless steel, high nickel alloy, or nickel silver, or component parts made therefrom, to the extent that any such materials were contained in a person's inventory on March 1, 1951, or had been ordered by that person and such order had been accepted by the producer for February 1951 production and received by that person in his inventory prior to June 1, 1951. This exception is applicable only to the extent that such materials are wholly unsuitable for use in the production, manufacture, or assembly by such person of any product not included in subheading A–I and A–II of that list.

[illegible]bitions contained in sec[illegible]chedule [illegible]

(d) Any unassembled component parts, produced prior to the issuance of, or in conformity with, this schedule, of products subject to the provisions of section 2 may be sold any time, and the purchaser thereof may assemble such component parts into products subject to the prohibitions of section 2 of this schedule at any time, provided such component parts are wholly unsuitable for use in the production, manufacture, or assembly of any product not prohibited.

(e) Notwithstanding that a product may be contained in the list under the subheadings A–I, B–I, and C–I, the prohibition contained in section 2 of this schedule shall not apply if any such product is manufactured exclusively for use on board vessels and aircraft operated by the Armed Forces of the United States, including the United States Coast Guard.

SEC. 4. *Records.* Every person who relies on the provisions of paragraphs (a), (b), or (c) of section 3 of this schedule shall prepare a detailed record showing: (a) the quantities of nickel-bearing stainless steel, high nickel alloy, and nickel silver, or component parts made therefrom, which were in his inventory on the first days of each month commencing with December 1950, and ending September 15, 1951, which were wholly unsuitable for use by him in the

IF YOUR PRODUCTION IS THREATENED BY THE CRITICAL MATERIAL CONTROLS

Is your product on this long list prohibited from using critical materials such as nickel-bearing stainless steel? Are you having difficulty obtaining aluminum or copper?

If you are, it will pay you to get all the facts regarding Sharon '430' Stainless Steel. This straight chrome stainless is the best available material today for many applications and has been used by hundreds of fabricators for thousands of products with great success. It has many of the qualities that have made stainless steel the most sought after metal today.

Sharon '430' is readily available with few restrictions as to end use. The Sharon Steel Corporation has prepared a special booklet giving information on Sharon '430'. To get yours, contact the Sharon office nearest you or write direct to ***Department 5852, Sharon Steel Corporation, Sharon, Pa.*** Engineering help and technical assistance, too, available without obligation.

SHARONSTEEL

...YOU CAN CONTINUE WITH

Sharon stainless 430

Use

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

RADIUM

for the tough weld inspection jobs

because radium-radiographing equipment is

1. **Portable**
2. **Easily handled**
3. **No training needed to operate**
4. **Economical**

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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

Write today for case histories and additional information.

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RADIUM CHEMICAL CO., INC.

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News Digest

Whyte, and was elected president of the company.

Joe S. Thompson has been appointed to the newly created position of vice president of the Townsend Co.

Riverside Metal Co. has announced the appointment of *M. W. Batchelor* as president.

Robert E. Workman, formerly St. Louis district manager of Goodyear Tire & Rubber Co.'s Chemical Div., has been named to the newly established post of manager of commercial development.

L. J. Campbell has been appointed president of Firestone Steel Products Co. Mr. Campbell has been vice president of the company since 1950.

Appointment of *G. Donald Campbell* as superintendent and *John A. McMillan* as plant engineer for Pittsburgh Plate Glass Co.'s Shelbyville, Ind., plant has been announced.

Jet Combustion, Inc., has announced the election of *Richard Smith* as president of the company to succeed the late *John E. Tegarden. Mrs. John Tegarden* has been named executive vice president; *Richard Kelly,* vice president in charge of engineering; and *Steve Kupres,* vice president in charge of field operations.

Ivan Speer has been named engineering manager at AiResearch Manufacturing Co.

The retirement of *Harry S. Wells* as staff plant engineer of Chrysler Corp. has been announced. Mr. Wells served the company for more than 36 years. He will be succeeded by *John von Rosen.* Also announced by the company was the appointment of *Theodore Ray Patrick* as general manager of the company's Highland Park Plant. Mr. Patrick succeeds *H. R. Matheny,* whose retirement was recently announced.

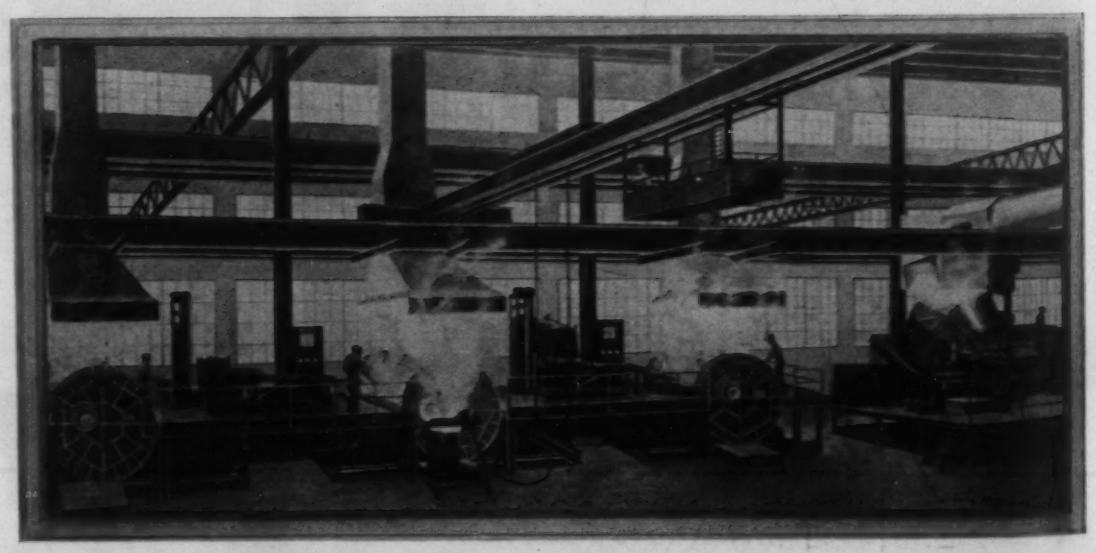
F. C. Boyce has been re-elected president of the D. J. Murray Manufacturing Co. for the 20th consecutive time.

Elliot C. Bacon has been named assistant manager of Solar Aircraft Co.'s Research Products Div. The company also announced the appointment of *Paul F. Voigt, Jr.* as consultant to the president on marketing methods and development of new products.

Dr. *Paul D. Merica,* executive vice president and a director, was elected president of the International Nickel Co. of Canada, Ltd.

American Cyanamid Co. has announced the appointment of Dr. *Nolan B. Sommer* as supervisor of the New Product Development Dept. Dr. Sommer replaces Dr. *James R. Dudley,* who recently

A NEW TOOL FOR INDUSTRY



This oil painting, 9 feet long in full color, by J. Gordon White, shows AJAX-SCOMET installation at Scovill Manufacturing Co., Waterbury, Conn.

Here is a new tool for melting metal . . . Something that can concentrate enormous power in a small space . . . Something that can be adapted to accurate pouring, to precise temperature control, to inert gas protection, to high grade refractories . . . A tool that can be used for all existing commercial metals and alloys.

AJAX furnaces paved the way for continuous casting processes which were dormant in old patents of farsighted inventors who thought ahead of their times. Write us for further information.

AJAX ENGINEERING CORP., TRENTON 7, N. J.

AJAX TAMA-WYATT

INDUCTION MELTING FURNACE

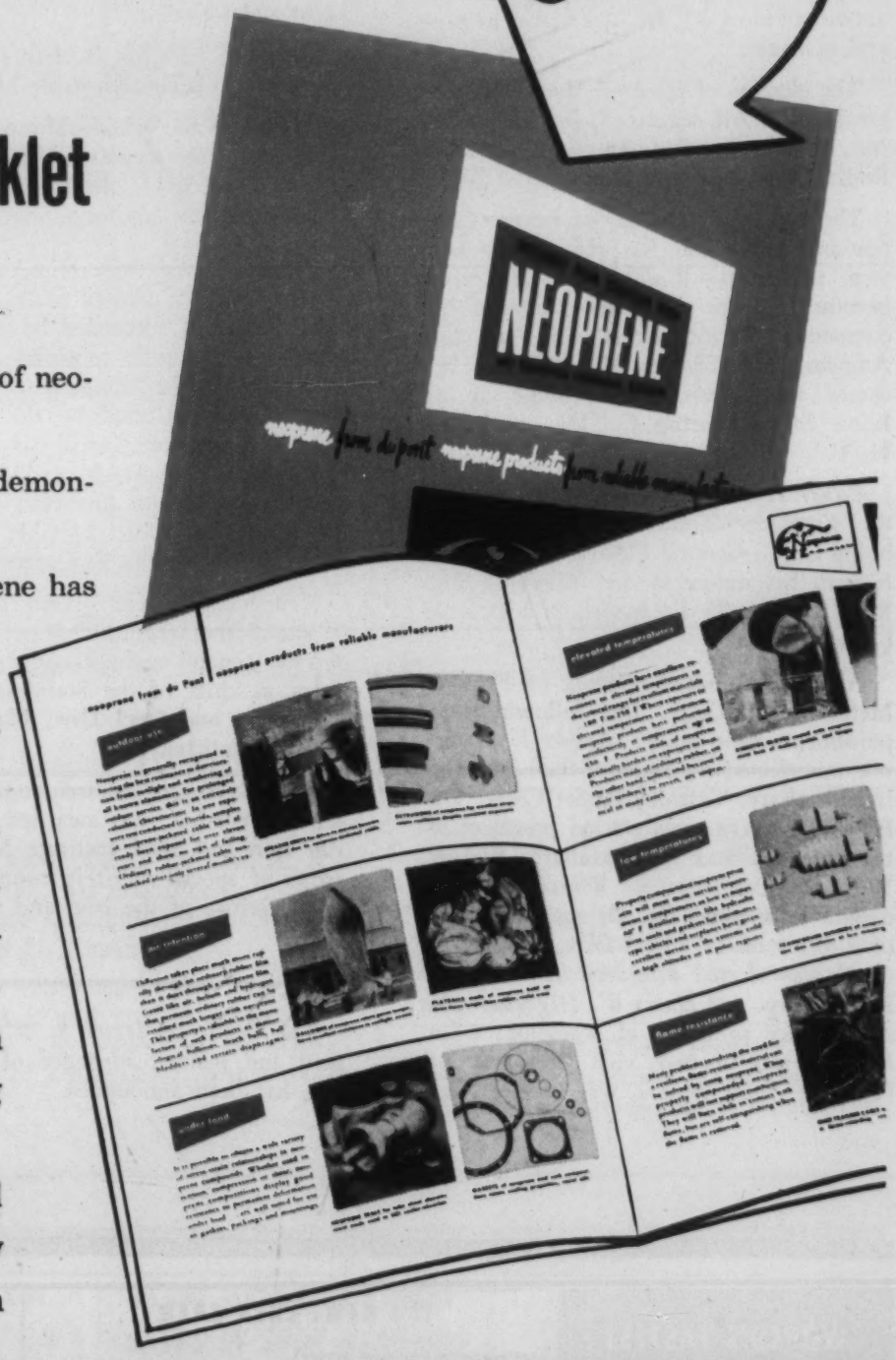
AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Vertical High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hydrogen Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Vertical Induction Furnaces for Melting

SEND FOR YOUR

"DESIGN FOR SUCCESS WITH NEOPRENE"

Informative Du Pont Booklet Gives You:

- **facts** about the outstanding properties of neoprene, Du Pont's chemical rubber
- **descriptions** of service conditions that demonstrate neoprene's superiority
- **examples** of products in which neoprene has outperformed other resilient materials



Designed for you, this illustrated booklet contains data on neoprene's properties, performance, and uses. It shows you why neoprene withstands service conditions that cause failure in many other resilient materials. Numerous pictures and tables illustrate how products made with neoprene can often outperform and outlast those using other elastomers.

To help you design new products . . . and improve old ones . . . be sure there's a copy of "Design for Success with Neoprene" in your file.

NEOPRENE

The rubber made by Du Pont since 1932

DU PONT
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150th Anniversary

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. . . THROUGH CHEMISTRY

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News Digest

joined the Carwin Co., North Haven, Conn.

Two important additions to the engineering staff have been announced by the Standard Machinery Co. *Nathaniel Little* and *Earl King* have joined the company as design engineers.

Damascus Tube Co. has announced the appointment of *W. H. Lagerstrom* as general manager.

The election of *Bernard Munson* as vice president of All America Cable and Radio, Inc., a subsidiary of American Cable & Radio Corp., has been announced.

The board of directors of Revere Copper and Brass, Inc. has elected two new vice presidents—*Wallace H. Hitchcock* becomes vice president in charge of the company's Pacific Coast Div. at Los Angeles, and *Chester M. McCreery* becomes vice president in charge of its Rome Manufacturing Co. Div. at Rome, N. Y.

Edgar A. Reed has joined the staff of the Customer Training School of Carboloy Dept., General Electric Co. In addition to his duties as die instructor, Mr. Reed will handle die service on a national basis.

At a recent board meeting of Fansteel Metallurgical Corp., the following appointments were made: *Robert J. Aitchison* was elected chairman of the board and its subsidiary, Vascoloy-Ramet Corp.; Dr. *Frank H. Driggs* was elected president of the company and its subsidiary, Weiger Weed & Co.; Dr. *R. Winchester* was named to succeed Dr. Driggs, with title of director of Technical Div.; *Herbert B. Clark* was elected president of Vascoloy-Ramet Corp. and *Harry W. Highriter* was elected vice president of Vascoloy; *Glen Ramsey* was named vice president of Fansteel; *John Meade* was elected vice president in charge of industrial relations; *Harry D. Weed* was elected vice president and general manager of Weiger Weed & Co.; *Joseph A. Teece* was re-elected vice president in charge of manufacturing.

Arthur C. Kleckner was recently named president of Webster Electric Co. to succeed *S. Arthur Loeb,* who was elected chairman of the board.

At the annual meeting of directors of Laclede-Christy Co., the following officers were elected: *J. D. Streett,* president; *A. B. Agnew,* vice president; *J. L. Cummings,* vice president; *L. C. Hewitt,* vice president; *Walter W. Shipley,* vice president and treasurer.

James T. Duffy, Jr. has resigned the presidency of The Riverside Metal Co.

Hanson-Van Winkle-Munning Co. has announced the appointment of *John H. Gorman* as field electrochemist in the Michigan-Ohio territory.

Irving S. Olds has retired as chairman of the board of United States Steel Corp. Mr. Olds was succeeded by *Benjamin F. Fairless,* who will continue to serve as president of the company. Mr. Fairless was recently selected by the John Fritz Medal Board of Award to receive the 1952 John Fritz Medal and Certificate as "Champion of the American Free Enterprise System for Notable Industrial Achievement in the Production of Steel".

Crucible Steel Co. of America has announced the appointment of *James D. Glenn,* general manager of stainless steel sales, as chief of the Stainless Steel Section, Iron and Steel Div., National Production Authority.

John S. Marsh, research engineer, Bethlehem Steel Co., was awarded the American Iron and Steel Institute Medal for a paper of special merit in connection with the activities of the iron and steel industry.

The death of *Jessel S. Whyte,* president and general manager of Macwhyte Co., has been announced.

International Telephone and Telegraph Corp. has announced the death of *John Millard Phelan,* former vice president and director of All America Cables and Radio, Inc.

The death of *Forest J. Smith,* assistant to the general superintendent of United States Steel's Fairless Works, has been announced.

News of Companies

Kewanee Boiler Corp. and *Ross Heater & Manufacturing Co., Inc.,* two divisions of *American Radiator & Standard Sanitary Corp.,* have combined to form a new company, *Kewanee-Ross Corp.*

A new plastic company, *Rel Plastics Corp.,* is now in full operation in East Paterson, N. J. Rel Plastics occupies its own modern plant and office building of approximately 15,000 sq ft, at 475 Blvd.

New quarters for *Harvey Aluminum,* a division of the *Harvey Machine Co., Inc.,* have just been opened in Chicago, at 35 E. Wacker Dr.

Speer Carbon Co. and its subsidiaries, *Jeffers Electronics, Inc., International Graphite and Electrode Corp.* and *Speer Resistor Corp.,* have consolidated into one company, the *Speer Carbon Co.,* with headquarters at Saint Marys, Pa.

The *Howard Foundry Co.* has purchased the *Investment Casting Div., Allis-Chalmers Manufacturing Co.*

Apex Smelting Co. has announced that it is constructing a commercial pilot plant in the Pacific Northwest. Using clays as a raw material, the plant will produce intermediate alloys containing aluminum and silicon.

1952 marks the 21st anniversary year

WORLD'S FASTEST FLAW LOCATION
TURCO
dy√chek
chek-spek
THE DYE PENETRANT METHODS
IT'S NEW! CHEK-SPEK
HERE'S TURCO'S NEW PRODUCTION-LINE METHOD OF FLAW LOCATION...SIMPLE, SAFE & ACCURATE. SAVES YOU MONEY & TIME!
DEVELOPED FROM TURCO'S FLEXIBLE DY-CHEK PROCESS. ACCEPTED BY THE AIR FORCE... AND BY THE NAVY
WELDING FOREMEN STATE
LASTING VISIBILITY OF FLAW INDICATIONS PERMITS ECONOMICAL RE-WORKING AT YOUR CONVENIENCE.
RE-WORK WELDERS SAY
MAKES EACH JOB EASIER BECAUSE WE CAN SEE WHERE THE DEFECTS ARE!

News Digest

of *Marmon-Herrington Co., Inc.*

Allied Chemical & Dye Corp. has announced the combination of the Nitrogen and Organic Chemicals Sections of its *Solvay Process Div.* and the Sales Agency Dept. of its *Barrett Div.*, into a new organization to be known as the *Nitrogen Div., Allied Chemical & Dye Corp.*, with executive offices at 40 Rector St., New York 6.

Quaker Rubber Corp., Div. of *H. K. Porter Co., Inc.*, has established a branch warehouse and sales office at 430 S. Mill St., Lockland 15, Cincinnati.

Hydraulic Equipment Co. has announced that it will operate as *Hydreco*, a division of *The New York Air Brake Co.*, instead of a subsidiary of that company.

A new multi-million dollar plant, more than 500,000 sq ft in size and employing 2500 people, will be built in Raleigh, N. C., by *Westinghouse Electric Corp.* The plant will manufacture watt-hour electric meters and is being constructed to provide additional facilities at the Division's Newark, N. J., headquarters plant.

The Sponge Rubber Products Co. has completed construction of companion facilities for the production of cellular rub-

CHIEF INSPECTORS REPORT
KEEPS ACCEPTABLE PARTS MOVING...ONLY SUSPECTED PARTS GO TO TRAINED INSPECTORS. SIMPLIFIES EVALUATION, CUTS DEPARTMENT COSTS.
PRODUCTION SUPTS. SAY
ELIMINATES INSPECTION BOTTLENECKS. PERMITS ONE MAN TO CHECK AS MANY PARTS PER HOUR AS HE CAN PICK UP AND PUT DOWN!
PLANT MANAGERS REPORT
SAVES IN-SHOP-HANDLING TIME. PERMITS IN-PROGRESS INSPECTIONS. AN EXCELLENT RECEIVING DEPARTMENT TOOL. YOUR PEOPLE WILL LIKE IT!

Turco Products, Inc., Dept. 104
832 East 62nd St.,
Los Angeles 1, Calif.

Gentlemen:

Please send me your latest information on the world's fastest flaw location methods—flexible ☐ Dy-Chek, or the production-line tool ☐ Chek-Spek, (check one or both). No obligation, of course.

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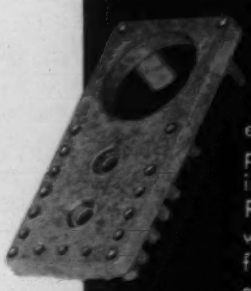
TITLE _____

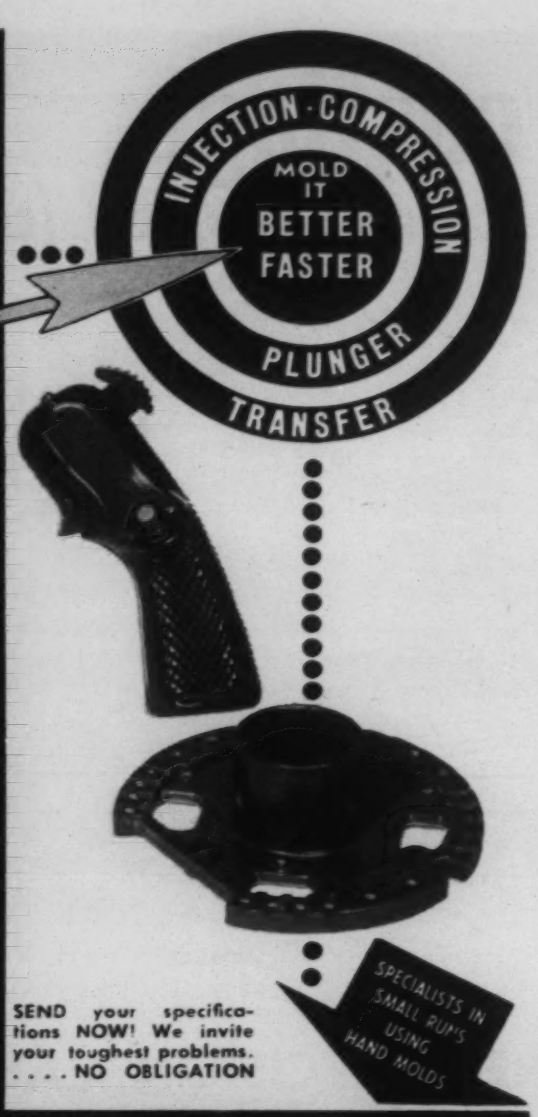
Simply staple coupon to company letterhead

PRIME CONTRACTORS SEE "ACCURATE" FOR MILITARY COMPONENTS

The manufacture of molded plastics for devices for military requirements is one of our specialties . . . thousands of military parts are in present production.



Considerate and experienced handling of your plastic molding problems is available thru ACCURATE SERVICE where you will find ample, modern facilities to meet your every plastic molding requirement . . . at MAXIMUM efficiency and economy.



SEND your specifications NOW! We invite your toughest problems. . . . . NO OBLIGATION

ACCURATE MOLDING CORPORATION 35-20 48th AVENUE LONG ISLAND CITY 1, N.Y.

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORPORATION, Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC COMPANY, INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORPORATION, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

News Digest

ber in Canada. At Waterville, Quebec, the completely new 67,000 sq-ft area plant of *Canadian Sponge Rubber Products, Ltd.*, will produce Spongex cord, sheets, die-cut shapes and custom molded forms.

Hagan Corp. has announced the establishment of its new *Aeronautical and Special Products Div.* to meet a growing demand for high performance regulating and measuring devices.

American Structural Products Co., subsidiary of *Owens-Illinois Glass Co.*, has changed its name to *Kimble Glass Co.* and has acquired the business and assets of the *Kimble Glass Div.*

Crucible Steel Co. of America has announced the opening of a new warehouse and branch office at 4920 E. Nevada, Detroit.

More than 3000 Edmore community residents and their families recently attended the open house held today by *Carboloy Dept.* of *General Electric Co.* in its new cemented carbide tool fabricating plant. The 8-hr long program, which began at two in the afternoon, featured guided plant tours, product displays, TV interviews, and a speaking program.

Plant capacity is being expanded by *Consolidated Industries, Inc.*, West Cheshire, Conn., to provide added facilities for its titanium forging operation. The expansion includes several new and larger drop hammers in order to provide a complete size range.

Kuhlman Electric Co. has announced the purchase of the assets of the *Queensboro Transformer and Machinery Co.* of Crystal Springs, Miss., and lease of a transformer manufacturing plant which has been under construction at Crystal Springs.

According to a recent announcement, *Metal Carbides Corp.* will start construction in the near future of a $1,000,000 plant on a 17-acre site located at Mathews Rd. and Southern Blvd., Boardman, Ohio. The new facility will have a monthly capacity of approximately 25,000 lb of tungsten carbide metal, tungsten alloy heavy-metal, titanium metal and other special alloys made from powdered metals.

Birdsboro Steel Foundry & Machine Co. has announced the formation of a new wholly owned subsidiary, *Birdsboro Armorcast, Inc.*, to make hull and turret castings for tanks. Officers of the newly formed corporation are J. E. McCauley, president; Marshall Post and G. Clymer Brooke, vice president; James M. Heppenstall, treasurer; and Lester E. Leinbach, secretary.

The opening of Lindberg Plant No. 2 at 2317 Grand Ave., Chicago, to manufacture laboratory furnaces, small induction heating units, Fisher type melting

CERTIFIED ZINC ALLOY PLAN

LICENSED PRODUCER

AMERICAN DIE CASTING INSTITUTE

WHEREVER YOU ARE YOU'RE NEAR A SUPPLIER OF ZINC DIE CASTINGS WHO DISPLAYS THIS SEAL OF QUALITY

It Costs No More to be Sure!

The **CERTIFIED ZINC ALLOY PLAN** is your assurance that the castings you obtain have been produced in a plant maintaining proper alloy control.

Regular sampling and analysis certify that the alloy used has been proven to be "on grade."

Why not be certain?

A & A Die Cast and Plastic Molds Co., West Los Angeles, Calif.
The Accurate Die Casting Co., Cleveland, Ohio
Advance Pressure Castings, Inc., Brooklyn, N. Y.
Advance Tool & Die Casting Co., Milwaukee, Wis.

Badger Die Casting Corp., Milwaukee, Wis.

Central Die Casting & Mfg. Co., Inc., Chicago, Ill.
Cleveland Hardware & Forging Co., Cleveland, Ohio
Congress Drives Division, Tann Corp., Detroit, Mich.
Continental Die Casting Corp., Detroit, Mich. Division of F. L. Jacobs Co.
Crown City Die Casting Co., Pasadena, Calif.

Doehler-Jarvis Corp., Pottstown, Penna.
Doehler-Jarvis Corp., Toledo, Ohio
Dollin Corporation, Irvington, N. J.
Du-Wel Metal Products, Inc., Bangor, Mich.

Federal Die Casting Co., Chicago, Ill.

Globe Imperial Corporation, Rockford, Ill.
C. M. Grey Mfg. Co., East Orange, N. J.

Heick Die Casting Corporation, Chicago, Ill.
Hilfinger Corporation, Toledo, Ohio
The Hoover Company, North Canton, Ohio

Kamin Die Casting & Mfg. Co., Chicago, Ill.
Kiowa Corporation, Marshalltown, Iowa
Paul Krone Die Casting Co., Chicago, Ill.

Madison-Kipp Corporation, Madison, Wis.
Milwaukee Die Casting Co., Milwaukee, Wis.
Monarch Aluminum Mfg. Co., Cleveland, Ohio
Mt. Vernon Die Casting Corp., Mt. Vernon, N. Y.

New Products Corp., Benton Harbor, Mich.

Paragon Die Casting Co., Chicago, Ill.
Parker White Metal Co., Erie, Penna.
Precision Castings Co., Inc., Syracuse, N. Y.
Precision Castings Co., Inc., Cleveland, Ohio
Precision Castings Corp., Inc., Chicago, Ill.
Pressure Castings, Inc., Cleveland, Ohio

Racine Die Castings Co., Racine, Wis.

St. Louis Die Casting Corp., St. Louis, Mo.
Schultz Die Casting Co., Toledo, Ohio
Sterling Die Casting Co., Inc., Brooklyn, N. Y.
Stewart Die Casting Div., of Stewart Warner Corp. Bridgeport, Conn.
Stewart Die Casting Div., of Stewart Warner Corp. Chicago, Ill.
Stroh Die Moulded Casting Co., Milwaukee, Wis.
Superior Die Casting Co., The, Cleveland, Ohio

The Tool-Die Engineering Co., Cleveland, Ohio
Twin City Die Castings Co., Minneapolis, Minn.

Union Die Casting Co., Ltd., Los Angeles, Calif.
Universal Die Casting Co., Los Angeles, Calif.

Wells Die Casting Co. of California, San Francisco, Calif.
Western Die Casting Co., Emeryville, Calif.

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News Digest

furnaces and atmosphere generators, has been announced by *Lindberg Engineering Co.*

Gustin-Bacon Manufacturing Co. has announced the opening of a Detroit office at 18323 James Couzens Highway. The office will be devoted solely to serving the needs of the automotive industry.

Apex Smelting Co. has acquired 20 acres within the Los Angeles, where it will construct a plant which is expected to be producing aluminum alloys by late fall.

The Du-Lite Chemical Corp. has just completed the transfer of all operations to its new plant on River Rd., Middletown, Conn.

A major expansion of the *Johns-Manville* plant at Watson, Calif., for the production of industrial insulations has been announced.

Construction work is scheduled to begin at once on *American Can Co.'s* new can manufacturing plant at Harrisburg, Pa. The new manufacturing facility will serve the expanding needs of fruit and vegetable canners in Eastern and Central Pennsylvania and the Appalachian areas of Maryland, West Virginia and Virginia.

News of Societies

Announcement of new officers for the ensuing year was recently made at the 50th Anniversary Meeting of the *American Society for Testing Materials.* Dr. Harold Lee Maxwell, supervisor of mechanical engineering consultants, E. I. du Pont de Nemours & Co., Inc., was named president, and Norman L. Mochel, manager, metallurgical engineering, Westinghouse Electric Corp., Lester Branch, was elected vice president. Authors of outstanding technical papers presented at previous meetings of ASTM received the following awards: The Charles B. Dudley Medal went to Norman W. McLeod, engineering consultant, Dept. of Transport, Ottawa, Canada; The Richard L. Templin Award was presented to Thomas J. Dolan, Research Professor, Theoretical and Applied Mechanics, University of Illinois; and the Sanford E. Thompson Award was received by H. F. Gonnerman and William Lerch, assistant to vice president in charge of research and administrative assistant, Research and Development Labs., respectively, of Portland Cement Assn.

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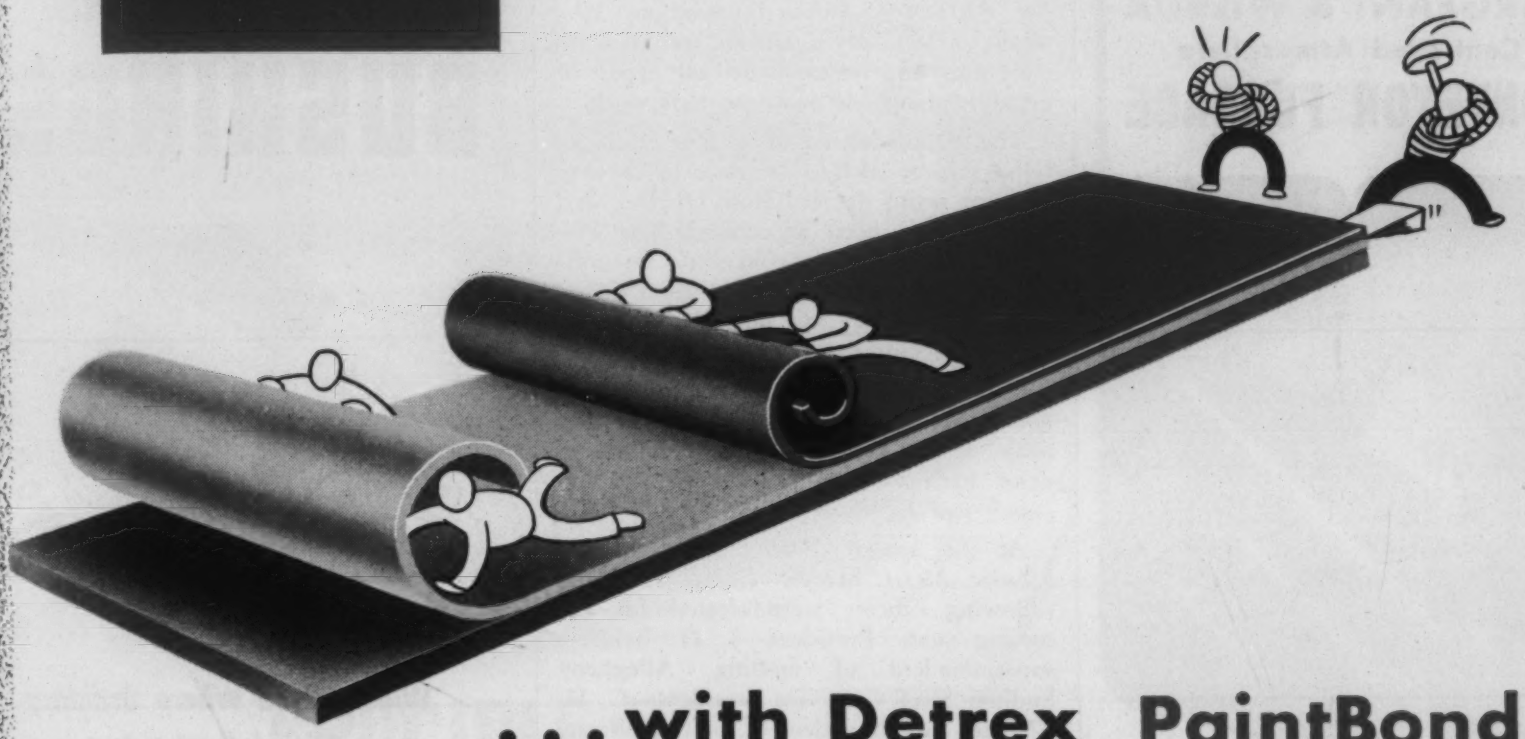

...with Detrex PaintBond

Detrex PaintBond effectively retards corrosion and serves as an excellent base for paint finishes on metal surfaces. Easily and quickly applied by spray or immersion means, it will add years of life to your product's finish.

Detrex PaintBond is a zinc phosphate coating which chemically interlocks itself on the metal's surface. Thus the metal surface is sealed off from moisture and other causes of corrosion. Since this coating provides a fine-grained crystalline surface, it also serves as an ideal base for paint and locks it securely to the metal. If the paint finish is scratched, PaintBond retards corrosion . . . and even when the scratch penetrates the coating, any corrosion that takes place is confined to the scratched area only.

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PARTS MADE OF STAINLESS can be

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News Digest

metals processing laboratory at the *Massachusetts Institute of Technology* were recently held in the presence of a distinguished group of scientists, industrialists and educators. The new building, provided by a gift of $1,000,000 from the Alfred P. Sloan Foundation, Inc., marks a step of significant progress in education and research in all types of metal forming and machine tool work.

The establishment of a new multiple fellowship at *Mellon Institute* to develop uses for resins derived from ethylene and acetylene has been announced. The Fellowship, sponsored by Bakelite Co., division of Union Carbide and Carbon Corp., will be headed by Dr. Richard W. Quarles, Senior Fellow.

The trustees and the board of governors have announced changing of the name of the *Foundation of Applied Reseach* to *Southwest Foundation for Research and Education.*

At the annual June meeting of the *Electric Metal Makers Guild, Inc.,* the following officers were elected for the coming year. President—J. H. Baldrey, superintendent of melting, Allegheny Ludlum Steel Co.; vice president—C. H. Wyman, superintendent of melting, Burnside Steel Co.; secretary-treasurer—C. B. Williams, superintendent of melting, Massillon Steel Casting Co.

Four engineering student winners of the second annual national scholarship contest sponsored by the *American Society of Tool Engineers* have been announced. They are: Merton L. Bartsch, senior in engineering at the University of Minnesota; Raymond F. Perner, mechanical engineering senior at University of Texas; Hearst McClellan, mechanical engineering senior at the University of Cincinnati; and David Lee Poli, industrial engineering senior at Ohio State.

Industrial Fasteners Institute has announced the election of F. R. Dickenson, president of Townsend Co., as vice president of the Institute.

The following new officers were elected at the annual meeting of the *American Society of Lubrication Engineers:* President—M. E. Merchant, senior research physicist, Cincinnati Milling Machine Co.; vice president at large—W. E. Campbell, in charge of research and development in lubrication and organic analysis, Bell Telephone Laboratory; secretary-treasurer—W. H. Fowler, Jr., chief industrial lubrication engineer, Pure Oil Co.

Gordon Brown was reelected president of *The Society of the Plastics Industry, Inc.* at the annual business meeting of the Society. Mr. Brown, a vice president of The Bakelite Co., division of Union Carbide and Carbon Corp., was a founder of the Society 15 years ago.

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SELF-LUBRICATING

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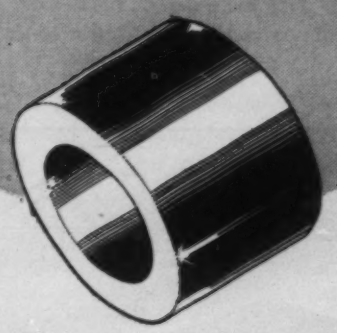

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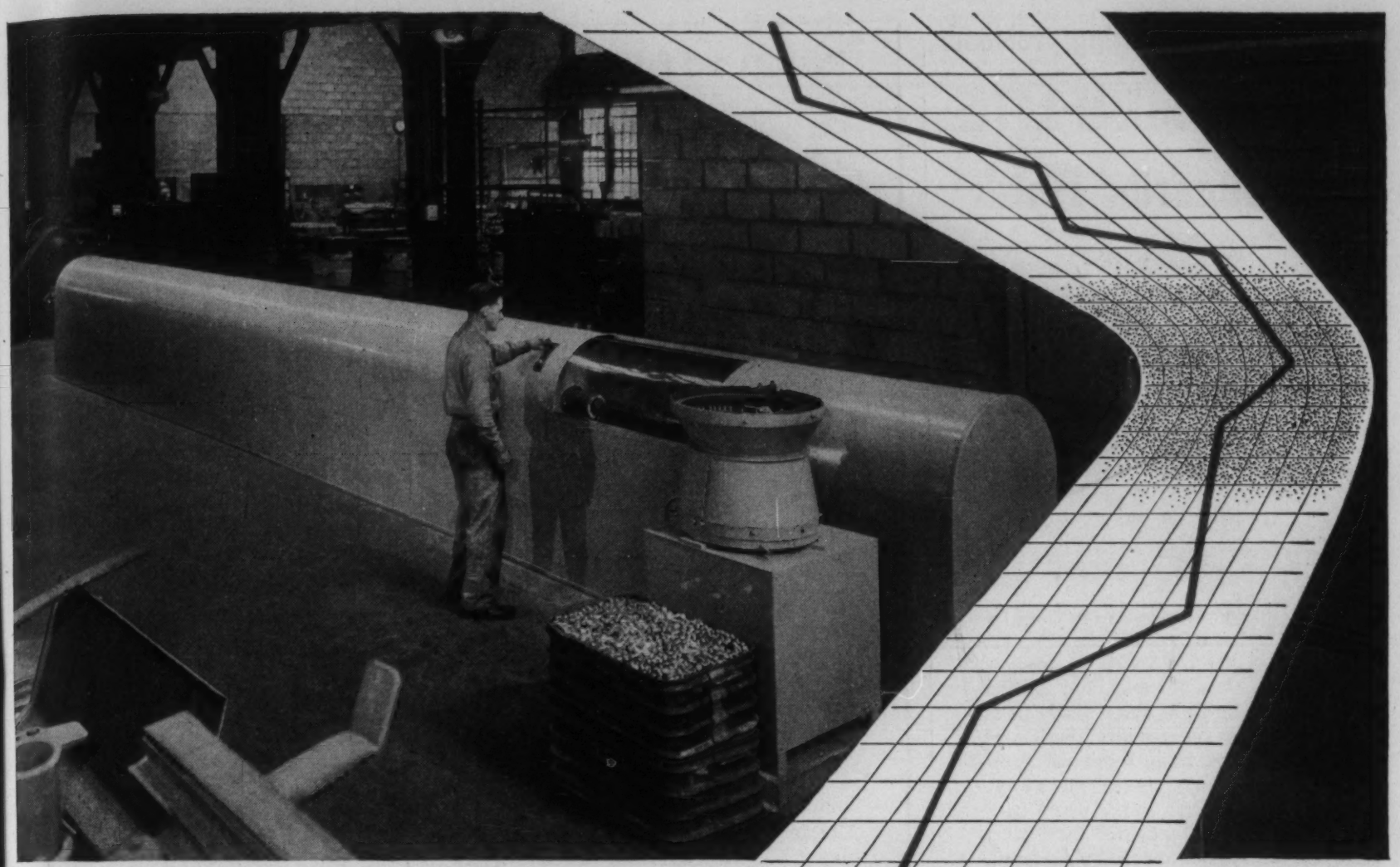

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Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

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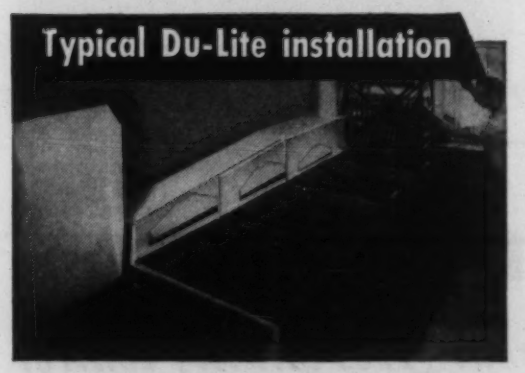

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Meetings and Expositions

OAK RIDGE SUMMER SYMPOSIUM. Oak Ridge, Tenn. Aug. 25-29, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Industrial Minerals Div. fall meeting. Chicago. Sept. 3-6, 1952.

AMERICAN STANDARDS ASSOCIATION, national standardization conference. Chicago. Sept. 8-10, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Chicago. Sept. 8-11, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div. and INSTRUMENT SOCIETY OF AMERICA, exhibit and joint conference. Cleveland. Sept. 8-12, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting. Milwaukee. Sept. 9-11, 1952.

AMERICAN CHEMICAL SOCIETY, national chemical exposition. Chicago. Sept. 9-13, 1952.

PORCELAIN ENAMEL INSTITUTE, annual shop practice forum. Chicago. Sept. 10-12, 1952.

PRESSED METAL INSTITUTE, annual meeting. Pocono Manor, Pa. Sept. 14-18, 1952.

NATIONAL FOUNDRY ASSOCIATION, annual meeting. Chicago, Sept. 18-19, 1952.

STEEL FOUNDERS' SOCIETY, fall meeting. Hot Springs, Va. Sept. 22-23, 1952.

NATIONAL ELECTRONICS CONFERENCE. Chicago. Sept. 29-Oct. 1, 1952.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Cleveland. Sept. 30-Oct. 3, 1952.

GRAY IRON FOUNDERS' SOCIETY, annual meeting. Cleveland. Oct. 16-17, 1952.

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION, annual meeting. White Sulphur Springs, W. Va. Oct. 16-18, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div. fall meeting. Philadelphia. Oct. 20-22, 1952.

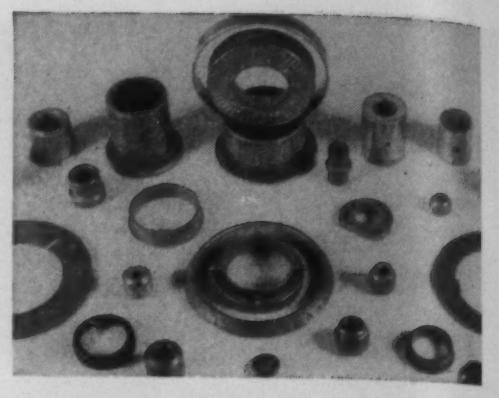
NATIONAL METAL CONGRESS & EXPOSITION. Philadelphia. Oct. 20-24, 1952.

PORCELAIN ENAMEL INSTITUTE, annual meeting. White Sulphur Springs, W. Va. Oct. 22-24, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, transportation meeting. Pittsburgh. Oct. 22-24, 1952.

AMERICAN SOCIETY OF BODY ENGINEERS, annual convention. Detroit. Oct. 2931, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fuels and AIME Coal Divs., joint conference. Philadelphia. Oct. 30-31, 1952.



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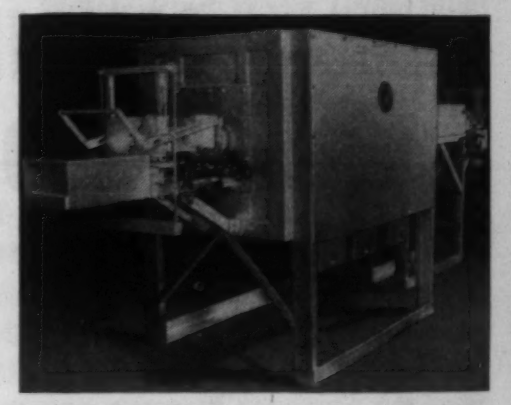

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